ICMMAS-2020

International Conference on Mathematical Modelling in Applied Sciences

June 28-30, 2020

Organised by

Department of Mathematics, Dibrugarh University,

Dibrugarh 786004, Assam

Book of Abstract

International Conference

on

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(ICMMAS2020)

June 28-30, 2020

Department of Mathematics

Dibrugarh University

Dibrugarh-786004, Assam, India

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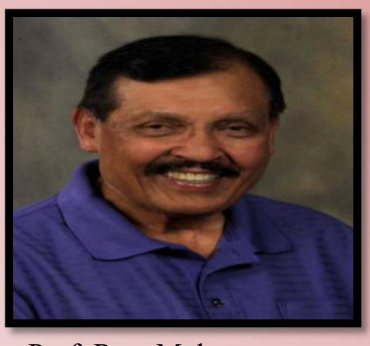

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MESSAGE

I am happy to note that Department of Mathematics, Dibrugarh University is organizing International Conference on Mathematical Modelling in Applied Sciences, (ICMMAS 2020) during-28 - 30 June, 2020.

The Conference will cover research works in different areas of Mathematical Sciences. Researchers from various institutes across the globe will attend the conference and share their thoughts. I am sure; learners will be highly benefitted from the conference.

So, I congratulate the Department of Mathemaics, Dibrugarh University on this occasion and wish them all the success for the conference.

Tamuli

(Prof. Ranjit Tamuli)
Vice-Chancellor
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DIBRUGARH UNIVERSITY
DEPARTMENT OF MATHEMATICS
DIBRUGARH, ASSAM

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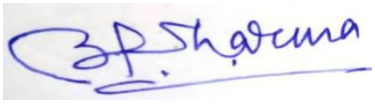
Date : 28.06.2020

Greetings from Dibrugarh University!!

I feel very happy to know that the Department of Mathematics, Dibrugarh University is organizing an International Seminar on Mathematical Modelling in Applied Sciences (ICMMAS 2020) during June 28-30. 2020. The theme of the conference is quite relevant and the topics like Bio-Mathematics, Fluid Dynamics, Decision Theory, Game Theory, Graph Theory, Numerical Linear Algebra, Plasma Dynamics, Uncertainty Modelling have immense practical applications in different areas of Sciences.

As I have been informed, more than 130 research paper have been presented. Some renowned personalities like Prof. G.D.Makinde, Stellenboch University of SouthAfrica, Prof. Oscar Castillo, Tijuwana Institute of Technolgy, Mexico, Prof. G. P. Raja Sekharan, IIT Kharagpur, Prof. Natesan Srinivasan, IIT Guwahati have shared their long years of experiences in their respective research fields during invited talks.

I congratulate the Convener and Head of the Department, Dr Ankur Bharali, the Coordinators Dr. Palash Dutta and Dr. Debasish Dey and all the members of the organizing committee for this wonderful endeavor to promote research in Mathematics and also improve the morale of the researchers, especially when the world is in despair.



(Prof B. R. Sharma)

DIBRUGARH UNIVERSITY
DEPARTMENT OF MATHEMATICS
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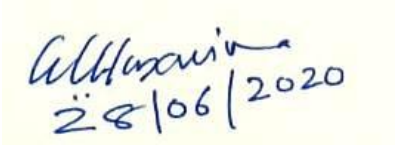
I feel honored and privileged to be involved in the International Seminar on Mathematical Modelling in Applied Sciences (ICMMAS 2020) during June 28-30. 2020. The general topic chosen for the conference is quite relevant and the topics like Bio-Mathematics, Fluid Dynamics, Decision Theory, Game Theory, Graph Theory, Numerical Linear Algebra, Plasma Dynamics, and Uncertainty Modelling have practical applications in different fields of real life problems of a very complicated and sophisticated present day world. Even some papers on the present Pandemic of Corona Virus have also been presented.

As I have been informed, more than 130 original research papers have been presented, including the invited talks from worldwide renowned personalities like Prof. G. D. Makinde, Stellenboch University, South Africa, Prof. Oscar Castillo, Tijuwana Institute of Technology, Mexico, Prof. G. P. Rajasekhar, IIT Kharagpur, Prof. Natesan Srinivasan, IIT Guwahati, who are masters in their respective fields having practical experiences.

This International online Seminar is quite successful one, especially at a time when the whole world is compelled to be at home isolation by this Pandemic. I congratulate the Department of Mathematics, Dibrugarh University for this great endeavor. It is also a fruitful deliberation not only to the researchers in the fields but also to the public. Sincere gratitude to the Head of the Department, Dr. Ankur Bharali and his team for successfully organizing such a fruitful international event, online.



(Prof. G. C. Hazarika)

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FROM THE CONVENER'S DESK

Greetings from Department of Mathematics, Dibrugarh University!!

It is indeed a great honour and pleasure to extend cordial welcome from the entire organizing team to our plenary and featured international and national speakers of the **International Conference on Mathematical Modelling in Applied Sciences (ICMMAS 2020).**

Amid the Covid-19 pandemic, when world is in turmoil, the economies are at nose drive, we must remember that tough times never last; only tough people and tough institutions do. To celebrate this untamed human spirit, our department has organized this virtual international conference during **June 28-30, 2020**. The main objective of ICMMAS 2020 is to keep the morale of the research community in place and to provide a platform to share their works with the colleagues and co-researchers. In response to our call, more than 130 researchers around the globe have come forward and presented their research papers in this conference.

I express my gratitude to our Vice-Chancellor Prof. Ranjit Tamuli and Dibrugarh University Administration, members of the organizing committee, especially the Coordinators, Dr. Palash Dutta and Dr. Debasish Dey and the research scholars of our department for their support in organizing the event in a befitting manner. I am grateful to all the invited speakers for their kind response in such a short notice. I also thank the Publication Division of Dibrugarh University for accepting our request to publish the book of abstracts. I sincerely thank the participants for considering our conference. And I hope this conference has given them a platform to exchange their ideas and enhance their quest for knowledge.

(**A. Bharali**)
Convener, ICMMAS 2020

PLENARY SESSION

PL-01
Mathematical modelling of tumor growth and mechanical behaviour

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Abstract: In this talk, we first introduce the basic structure of tumors and consequently present some fundamental modelling aspects of tumor growth (temporal-spatio-temporal). These are mostly restricted to ODE based approach. We then move on to PDE based approach where the biphasic mixture theory based mathematical model for the hydrodynamics of interstitial fluid motion and mechanical behavior of the solid phase inside a solid tumor. We introduce what is called in-vivo and in-vitro tumors. Consdering an isolated deformable biological medium. The solid phase of the tumor is constituted by vasculature, tumor cells, and extracellular matrix, which are saturated by a physiological extracellular fluid. The mass and momentum equations for both the phases are coupled due to the interaction (or drag) force term. The criterion for necrosis will be shown via the nutrient transport.

PL-02
Approximate analytical solution of KdV type equation

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Abstract: Approximate analytical solution of KdV type equation *viz.* KdV equation with damping term, KdV equation with force term and KdV equation with damping and external force term are obtained. The damping term in KdV equation arises from the dust ion collision in dusty plasma. The force term may arise due to some experimental or physical situation and is consider in the form of $f_0 \cos \omega t$ where f_0 is the strength of the force ω is the periodic function associated with the periodic force. It is known that KdV equation satisfy infinite conservation laws. Here we consider the energy $\int_{-\infty}^{\infty} \varphi^2 d\xi$ is constant. We know that the amplitude, width and Mach number of the soliton solution of the KdV equation do not depend on time . Here we assume the solution of the KdV type equations in presence of damping and force term is similar to the solution of the KdV equation but in this case the amplitude, width and Mach number are depends on time . The analytical solution is considered for small value of dust ion collision frequency and small f_0.

PL-03
Graphs Equienergetic with Their Complements

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Abstract: The energy Ɛ(G) of a graph G is defined as the sum of the absolute values of the eigenvalues of the adjaceny matrix of G. Two non-cospectral graphs G_1 and G_2 of same order are said to be equienergetic if Ɛ (G_1) = Ɛ (G_2). Several equienergetic graphs have been designed. In this paper We report the construction of graphs G such that $\mathcal{E}(G) = \mathcal{E}(\overline{G})$, where $\overline{G}$ is the complement of G.

PL-04
Modelling Heat Transfer Enhancement of MHD Nanofluid Flow Past a Stretching/Shrinking Slippery Surface

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Abstract: The enhancement of heating or cooling in an industrial process may save energy, reduce process time, raise the thermal rating and lengthen the working life of equipment. The development of high performance thermal systems for heat transfer enhancement has become popular nowadays. Consequently, the advent of high heat flow processes has created significant demand for new technologies to enhance heat transfer. The emergence of modern materials technology has provided the opportunity to produce metallic

and non-metallic nanometer-sizedparticles that can be uniformly and stably distributed in a base fluid to form what is called a nanofluid. The enhanced thermal conductivity, electrical conductivity, conduction andconvection coefficient properties of a nanofluid has made it a better, ultrahigh-performance thermal fluid for a wide range of engineering and industrial applications. In this paper, the combined effects of the magnetic field and Navier slip on heat transfer enhancement of a conducting, water-based nanofluid flow over a convectively-heated stretching or shrinking sheet is examined. The governing nonlinear model problem is obtained and tackled numerically using the shooting method with the Runge-Kutta-Fehlberg integration scheme. Pertinent results are displayed graphically ad discussed quantitatively.

Keywords: Heat Transfer Enhancement; Magneto-Nanofluid; Stretching/Shrinking Surface; Navier Slip; Convective heating.

PL-05
Optimization of Type-2 Fuzzy Systems: Theory and Applications

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Abstract: Type-2 fuzzy systems are powerful intelligent models based on the theory of fuzzy sets, originally proposed by Prof. Zadeh. Most real-world applications up to now are based on type-1 fuzzy systems, which are built based on the original (type-1) fuzzy sets that extend the concept of classical sets. Type-2 fuzzy sets extend type-1 fuzzy sets by allowing the membership to be fuzzy, in this way allowing a higher level of uncertainty management. Even with the current successful applications of type-1 fuzzy systems, now several papers have shown that type-2 is able to outperform type-1 in control, pattern recognition, manufacturing and other areas. The key challenge in dealing with type-2 fuzzy models is that their design has a higher level of complexity, and in this regard the use of bio-inspired optimization techniques is of great help in finding the optimal structure and parameters of the type-2 fuzzy systems for particular applications, like in control, robotics, manufacturing and others. Methodologies for designing type-2 fuzzy systems using bio-inspired optimization in different areas of application are presented as illustration. In particular, we will cover Bee Colony Optimization, Particle Swarm Optimization, Gravitational Search and similar approaches to the optimization of fuzzy systems in control applications, robotics and pattern recognition. Finally, we will also consider using fuzzy logic for enhancing the performance of metaheuristics, where also good results have been achieved.

PL-06
Numerical Simulation of Burger's and Navier-Stokes Equations using Moving Meshes

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Abstract: In this talk, we focus on the numerical simulation of the viscous Burger's equation and the incompressible Navier-Stokes equations. Generally, the solution of Burger's equation exhibit boundary layers, in order to obtain uniformly convergent numerical solution, we apply the finite difference scheme on layer-adapted moving meshes obtained through mesh equidistribution principle.
Further, we study the simulation of the Navier-Stokes equations in domains with moving boundaries. Arbitrary Lagrangian-Eulerian is used to transform the problem from the moving domain to a fixed reference domain; this is achieved with the help of an artificial domain velocity. To solve the resultant Navier-Stokes equation in the fixed domain, we use the characteristic method. For the interfaces, suitable boundary conditions are used. The proposed method is applied to three different problems and the results are compared with the earlier results.

PL-07
Modelling of ecosystem using graph theory

Madhumangal Pal
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Abstract: Mathematical modelling is a very important topic of mathematics. Any ecosystem can be modelled using a graph. In particular, a food web in an ecosystem is represented by a digraph. In this diagraph, the species are consider as vertices, and there is a directed edge between two species (vertices) *a* and *b* if *a* is a prey for the predator *b*. A weight on an edge can also be assigned depending on the amount of consumption of prey by a predator. The competition graph is also defined for this diagraph. Finally, the energy of food web is determined.

INVITED TALKS

IN-01
From Egalitarian to Marginal value: The Role of Solidarity in Cooperative Games

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Abstract: Cooperative Games are defined and various solution concepts are highlighted. The balance between Marginalism and Egalitarianism in determining the distribution of resource is justified. The Egalitarian Shapley value is defined to emphasis upon this balance between the two extremes. Finally a new solution concept is proposed which moves from egalitarian to marginal with the increase of the group size of the players. The corresponding characterization is also obtained.

IN-02
Type-1 and Type-2 Fuzzy Logic Inference Systems and its Application in Polypropylene Business

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Abstract: The polypropylene is a versatile thermoplastic resin available in a wide range of formulations for engineering applications. This research work presents a new approach to predict the quality of polypropylene in chemical plants. A model is constructed based on a large number of data collected from a renowned petrochemical plant in India and used to predict the polypropylene quality through the proposed approach. The quality of polypropylene depends on the indices like melt flow index and the xylene solubility of the product. The parameters controlling these two indices are hydrogen flow, donor flow, pressure and temperature of polymerization reactors. Using these four input and two output parameters, four Mamdani **type-1 and type-2 fuzzy** inference systems are constructed depending on the different membership functions of the variables. The model outcomes are then compared with the collected plant data and a sequence of statistical data analyses selects the most suitable model among them. Some sensitivity analyses with respect to some parameters are also performed to validate the proposed models. The raw materials for producing polypropylene are very much costly specially the catalyst teal. So the desired grade of PP is not achieved by the trial and error run then the production cost becomes uncontrollable. With the help of our proposed approach by controlling some parameters during the production phase, the quality of polypropylene can be improved.

IN-03
Spectral quasi-linearization method for fluid dynamics problems in non-linear differential equations

Hiranmoy Mondal
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Abstract: This study is concerned with the solution of fluid flow equations using the spectral quasilinearization methods. We first establish the relative accuracy of the method by using the method to solve various linear and non-linear ordinary and partial differential equations.
Prior to using these methods to solve equations arising from fluid flow problems whose solutions are not known, the accuracy and appropriateness of these methods is tested using various differential equations whose exact solutions are known. Mathematical concepts such as the consistency of a numerical scheme, the stability, and convergence of a numerical solution are discussed. We found that the ease in implementation and fast rate of convergence of the spectral quasi-linearization method gives the method an edge over the non-standard finite difference method. In each of the equations considered, the spectral collocation method expectedly performs better, converges faster and uses less computational memory and time than the non-standard and standard finite difference methods. A decisive factor is the fact that the spectral quasi-linearization method uses information in the entire computational domain and the error follows a spectral rate of

convergence, unlike the finite difference schemes which use information at neighboring grid points to evaluate the value of the dependent variables in each case.

Keyword: Nonlinear differential equation; Spectral quasilinearization methods.

IN-04
On Some group structures of the Genetic Code

Tazid Ali
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Abstract: The *genetic code* is the rule by which DNA stores the genetic information about formation of protein molecules. Each DNA molecule is a long sequence of nucleotides or bases, viz. Adenine(A), Cytosine(C), Guanine(G) and Thymine(T). Three consecutive DNA bases forms a unit called codon. Each codon encodes instruction for formation of a particular amino acid. A chain of amino acids gives a protein. There are 20 amino acids which are coded by the 64 codons. Mutation is a change in the DNA sequence where deletion, insertion or substitution of nucleotides may take place. Based on the number of hydrogen bonds and physic-chemical properties of the bases several group structures can be defined on the base set {A, C, G, U}. This in turn can be exploited to give different algebraic structures on the set of codons. We have considered one such group structure on the set of codons. In this paper we have shown that the subgroups and the quotient groups of the genetic code are in fact generated by some specific type of mutations. We have also observed some interesting characteristics of the quotient groups. We have further shown that group action under different subgroups is mediated by specific types of mutations.We have obtained different orbits for these group actions describing some interesting relation between algebraic structures and physic-chemical properties of amino acids.

Keywords: Genetic code, mutation, quotient group, group action.

IN-05
Hard and Easy Instances of L-Tromino Tilings

Manjil Saikia
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Abstract: We study tilings of regions in the square lattice with L-shaped trominoes. Deciding the existence of a tiling with L-trominoes for an arbitrary region in general is NP-complete, nonetheless, we identify restrictions to the problem where it either remains NP-complete or has a polynomial time algorithm. This is based on joint work with Javier T. Akagi, Carlos F. Gaona, Fabricio Mendoza and Marcos Villagra.

CONTRIBUTORY TALKS

TRACK—I

FM-01
Numerical Investigation on an Unsteady Free Convective flow of a MHD Micropolar Fluid over a Vertical Cone

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Abstract: The purpose of this study is to present a numerical investigation on an unsteady laminar free convective MHD micropolar fluid flow along with the combined effects of chemical reaction and heat generation/absorption over a vertical cone. Fluid viscosity and thermal conductivity are supposed to vary inversely with respect to temperature. The dimensionless governing partial differential equations are solved by finite differential scheme using MATLAB. The velocity, microrotation, temperature and concentration profiles have been studied for temperature dependent viscosity, thermal conductivity and for other important parameters involved in the problem as well as the skin friction coefficients, Nusselt number and Sherwood number are discussed. Finally the results obtained are shown graphically and in tabulated form and analyzed in detail.

Keywords **:** Micropolar fluid, MHD, viscosity, thermal conductivity, finite difference.

FM-02
Entropy Generation Analysis on MHD Boundary Layer Flow of Micropolar Fluid over an Exponentially Stretching Sheet

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Abstract: This study intends to investigate the effects of variable magnetic field and suction/injection on the micropolar fluid flow with both heat and mass transfers over an exponentially stretching/shrinking sheet. The governing flow equations have been solved using similarity transformations and MATLAB built-in bvp4c solver technique. The nature of flow with heat and mass transfers characteristics for various values of flow parameters are presented graphically. Also, an entropy generation analysis has been carried out using this flow model.

Key words: MHD, Micropolar fluid, Heat transfer, Mass transfer, exponentially stretching/shrinkingsheet, Entropy generation.

FM-03
Stability Analysis on Dual Solutions of MHD Casson Fluid Flow with Thermal and Chemical Reaction over a Permeable Stretching Sheet

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Abstract: An effort has been made to study the nature of dual solutions (steady and unsteady) for Casson fluid flow with heat and mass transfers phenomena. The flow passes over a permeable stretching sheet in the presence of uniform magnetic field. The governing equations are remodeled into a set of ordinary differential equations with the help of suitable similarity transformations and hence solved by "***MATLAB routine bvp4c scheme***". Due to the

sudden changes of temperature and flow behaviours with the sheet, the dual solutions exist. A stability analysis is executed to examine the less (more) stable and physically achievable solutions.

Keywords: MHD, Casson fluid, Chemical reaction, Stability analysis, Porous medium.

FM-04
Rheology on Stagnation Point MHD Flow in A Saturation Porous Medium with Energy Dissipation using Power Law Fluid Model

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Abstract. An investigation on 2-D stagnation point flow past a stretching or shrinking surface in a porous medium with energy dissipation using power law model is carried out in this paper. By applying some similarity transformation, the governing partial differential equations are converted to non-linear ordinary differential equations. Consequently, numerical calculations of these equations are done by using MATLAB built- in bvp4c method. Impact of various parameters such as Prandtl number, permeability parameter and magnetic parameter are depicted graphically on velocity and temperature distributions. Also, the numerical values for velocity gradient and shear stress are shown in tabular form. From the analysis, it is noted that Prandtl number helps in reducing the shear stress, Also, as the power law parameter increases, a decrease in velocity is observed.

Keywords: stagnation point flow, stretching surface, shrinking surface, power law model, bvp4c method.

FM-05
Effects of Heat Source and Chemical Reaction over a Shrinking Sheet for Stagnation Point MHD Flow of Micropolar Nanofluid

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Abstract: The present study investigates numerically MHD flow of micropolar nanofluid through a shrinking sheet near the stagnation point with heat source and chemical reaction. The study is an attempt to investigate the flow behaviour of micropolar nanofluid through a shrinking sheet because of its importance in heat transfer process in industries as well as cooling systems. Similarity transformations are used to transform the nonlinear system of partial differential equations to the system of nonlinear ordinary differential equations. Numerical results are obtained in the form of figures and tables by using MATLAB built in solver bvp4c for various dimensionless parameters. The effect of heat generation/absorption parameter on temperature and chemical reaction factor on concentration of the nanofluid are illustrated in the form of graphs. It is observed that the temperature of the nanofluid and nanoparticle volume distributions increase for larger values of Biot number. The thermophoresis and Brownian motion parameters on nanoparticle volume distribution show reverse effects when the values of the parameters are increased. Numerical data are presented for Nusselt number, Sherwood number and skin friction coefficient for different values of parameters.

Keywords: Micropolar nanofluid, Shrinking sheet, Heat source, Chemical reaction, Brownian motion, Thermophoresis

FM-06

Stagnation point flow of chemically reactive Maxwell nanofluid with variable thermal conductivity under slip effects

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Abstract: Present paper intends to analyze the impacts of chemical reaction and variable thermal conductivity on stagnation point flow of Maxwell nanofluid over a stretching surface with the viscosity being variable under slip effects. A Maxwell fluid is a viscoelastic fluid having the properties both of elasticity and viscosity. Such a model is relevant in modelling behaviour of some polymers and geomaterials. In previous studies the fluid viscosity and thermal conductivity for Maxwell fluid were assumed to be constant and presence of nanoparticles was not considered. These give the novelty of the present study. The similarity ordinary differential equations are formed from the governing partial differential equations by employing suitable similarity transformations. With the help of bvp4c, a built in solver of MATLAB, the transformed equations are then solved numerically and the results for velocity, temperature and concentration are presented in the form of graphs for various values of the parameters. It has been observed that chemical reaction and thermal conductivity reduce the thermal boundary layer thickness, favouring the rate of mass transfer and the fluid motion whereas the Deborah number and viscosity have reverse effects. Also the fluid temperature and nanoparticles volume fraction are enhanced by velocity slip but opposite effects are shown by suction, thermal and solutal slips. This present study can find applications in the process involving engineering and nanofluid operations.

FM-07

Effects of Variable Viscosity and Thermal Conductivity on Unsteady Free Convection Flow past an Impulsively Started Infinite Vertical Plate with Newtonian Heating in the presence of Thermal Radiation and Mass Diffusion

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Abstract: The influence of variable viscosity and thermal conductivity on unsteady free convection flow past an impulsively started infinite vertical plate with Newtonian heating in the presence of thermal radiation and mass diffusion is examined. Both the fluid viscosity and thermal conductivity are considered as an inverse linear function of temperature. The governing boundary layer equations with associated boundary conditions are converted to non-dimensional form. The magnetic Reynold number is assumed to be so small that the induced magnetic field can be neglected. The resulting non-linear partial differential equations are then solved using an iterative method for an implicit finite difference scheme. Effects of various flow governing parameters on the fluid velocity, temperature and concentration fields are presented graphically. Further, the numerical values of skin-friction co-efficient, Nusselt number and Sherwood number are computed and presented in tabular form.

Keywords: Variable viscosity, thermal conductivity, Mass transfer, unsteady free convection flow, Thermal radiation, MHD.

FM-08

Three Dimensional Generalized Problem of ThermalBending Analysis in The Cylindrical Domain

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Abstract: This is an attempt for mathematical modeling and analytical solution of the most generalized thermal bending problem in the three dimensional Cylindrical domain. The problem has been formulated in the context of non-homogeneous transient heat conduction equation subjected to Robin's boundary conditions. The key idea behind the solution of heat equation is to transform the original initial and boundary value problem into eigenvalue problem through the Strum-Liouville theory and a joint application of double finite Fourier transform with finite Hankel transform by choosing suitable normalized kernels. The well posedness of the problem has been discussed by the existence, uniqueness and stability of the analytical solution. The general analytical solution of generalized thermoelastic problem has been discussed for temperature change, deflection and thermal stresses. Using this most generalized mathematical formulation and its analytical solution any special case of practical interest may be easily obtained. There are 243 such combinations of possible boundary conditions prescribed on cylinder shaped region.

Keywords: Thermal bending analysis, Thermal stress function, Strum-Liouville problem, Integral transforms.

FM-09

Effect of Chemical Reaction on Heat and Mass Transfer Flow in presence of Radiation and Rotation with Variable Temperature And Concentration

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Abstract: A parametric study to investigate the effect of chemical reaction parameter on an MHD mixed convective mass transfer flow of an incompressible viscous electrically conducting fluid past an infinite vertical porous plate. The magnetic Reynolds number is assumed to be so small that the induced magnetic field can be neglected in comparison with the applied magnetic field. The resultant set of the non-dimensional governing equations are solved analytically by adopting Laplace transform technique. The profiles of the velocity, temperature, concentration, skin friction, Nusselt number and Sherwood number at the plate are demonstrated graphically for various values of the parameters involved in the problem and the results are physically interpreted. It is found in our discussion that due to the increase in chemical reaction parameter, the fluid motion is decelerated.
Keywords: MHD, mass transfer, Sherwood number, chemical reaction parameter.

FM-10

Flow of Two Phase Fluid over a Stretching Curved Surface

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Abstract. A steady two phase fluid flow past a curved stretching sheet with dust particles has been investigated. Also, presence of volume fraction, applied magnetic field, buoyancy driven force on the flow over a porous medium has been studied. Using similarity transformations, partial differential equations of the problem for both fluid and dust phases

are transformed into ordinary differential equations. Then, resulting non-linear differential equations are solved numerically using MATLAB built-in bvp4c solver. Velocity, temperature and concentration profiles have been shown graphical forms for various values of flow parameters. Coefficient of skin friction, rate of heat and mass transfer are calculated and given in tabular forms.

Keywords: Dusty fluid flow, volume fraction, stretching sheet, porous medium

FM-11
Influence of Inclined Magnetic Field on Non-Newtonian Dusty Fluid Flow in a Channel

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Abstract: A theoretical investigation of the influence of inclined magnetic field on the flow of non-Newtonian fluid with dust in a channel has been considered. The non-Newtonian fluid is characterized by second-order fluid. The governing partial differential equations are obtained and solved analytically. The analytical expression for velocity field, temperature field and shearing stress at the channel are obtained. The results are illustrated graphically to study the effect of non-Newtonian parameter in combination with other flow parameters involved in this study.

FM-12
Effects of Cross Diffusion on Triple Diffusive Convection in a Porous Medium

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Abstract: The effects of cross-diffusion on linear and weakly nonlinear convective instability in a triply diffusive and triply stratified fluid saturated horizontal porous layer are investigated using the Brinkman extended Darcy model having fluid viscosity different from effective viscosity. The criteria for the onset of steady and oscillatory convection are obtained analytically. Depending on the magnitude of stratifying agencies, the linear stability analysis shows that cross diffusion terms can either stabilize or destabilize the system. A systematic study on the evolution of neutral curves is carried out by varying off-diagonal elements of the diffusivity matrix and also other physical parameters to know their sensitivity on the determination of stability criteria. Even small variations in the cross-diffusion terms are found to affect the preferred type of instability. Under certain conditions, numerical calculations further reveal that a heart shaped disconnected neutral curves lie below the steady neutral curve implying requirement of three Rayleigh numbers to specify linear stability criteria instead of a usual single value.

FM-13
Flow of non-Newtonian nanofluid on a rough rotating disk during spin coating process

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Abstract: In this article, we have discussed the behavior of the flow and film thickness variation of non-Newtonian nanofluid on a rough rotating disk during spin coating process. Viscosity is not constant is case of non-Newtonian nanofluid. In this paper, we are taking SWCNT(Single wall carbon nanotube) and MWCNT(Multi wall carbon nanotube) as nanoparticles and sodium alginate as a non-Newtonian base fluid. Here we discuss the behavior of the film thickness for different parameters such as initial film thickness, angular velocity of the rotating disk, volume fraction of the nanoparticle, azimuthal roughness parameter, radial roughness parameter etc.

Keywords: Nanofluid, Carbon nanotube, Volume fraction, Spin coating.

FM-14

Heat Transfer for visco-elastic Stagnation point flow with partial slip at the boundary over a linearly shrinking surface

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Abstract: An investigation has been initiated to study the heat transfer for visco-elastic stagnation-point flow with partial slip at the boundary over a linearly shrinking surface. The visco-elastic fluid model Walter Liquid (Model B′) is considered. The fluid motion is governed by a set of partial differential equations which are converted to self-similar ordinary differential equations by careful inspection with the help of similarity variables. The transformed resulting governing equations of fluid motion are solved numerically by employing inbuilt MATLAB solver 'bvp4c'. The evaluated numerical results of fluid velocity, shear stress, temperature and temperature gradient are plotted. The flow pattern is observed from graphs for different values of visco-elastic, slip and velocity ratio parameters for discussion from physical point of view. The variations in parameters result in oscillations in the fluid flow and shear stress curves. The temperature of the fluid is significantly affected by the involved flow parameters.

Keywords: Stagnation-point flow, Visco-elastic fluid, Partial slip boundary, Velocity ratio, Heat transfer.

FM-15

Impact of Thermophoresis and Suction on A MHD Nanofluid over a Stretching Sheet in Porous Medium

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Abstract: In this paper, we have analyzed MHD mixed convection boundary layer flow, heat and mass transfer of water based nanofluid containing nano particles of Fe_3O_4, Cu and Ag over a stretching sheet with various controlling non- dimensional parameter like chemical reaction, suction/injection, heat generation, nanoparticle volume fraction, Soret number, Eckert number, porosity and described graphically in details. The governing PDE's are altered via appropriate similarity transform and combination of R-K 4^{th} order and Shooting method is employed to solve the converted ODE's by MATLAB. The impact of suction/injection and Soret number is noteworthy. Furthermore, for greater nanoparticle volume fraction (ϕ), the velocity is diminished, while a reversed situation is observed for temperature distribution. An outstanding validation of this model is accomplished. Nanofluids are used in abundant applications involving heat transfer, biomedical, automotive, food processing and many more.

Keyword*:* Soret effect, Heat generation, nanoparticles volume fraction.

FM-16

Combined Effects of Heat and Mass Transfer with Suction on Three Dimensional Unsteady Visco-Elastic Flow through a Porous Plate

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Abstract: This paper focuses on a unsteady three dimensional visco-elastic fluid flow with variable suction along a vertical porous plate in presence of heat and mass transfer. The expressions for velocity profile, temperature and concentration have been derived analytically using multi-parameter scheme. The effects of different involved parameters such as suction parameter, Prandtl number, Schmidth number, Grashof number for heat and mass transfer on velocity, temperature and concentration profiles are plotted and discussed graphically.

Keywords: Visco-elastic, Heat and Mass Transfer, Porous medium, Suction

FM-17

MHD Flow of Micropolar Fluid Over a Radiative, Rotating Vertical Plate in Second - Order in Slip Flow Regime

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Abstract: This paper concerned with the study of an unsteady flow of viscous, incompressible micro polar fluid over an infinite moving vertical permeable plate embedded in a porous medium in rotating system with second order slip flow incorporating Hall current, thermal radiation, chemical reaction and Soret effect .The governing equations are solved analytically to obtain the expressions for velocity, micro rotation, temperature and concentration. The effects of various parameters involved in the flow problem are studied and depicted by graph or table. It is seen that the observed parameters have a significant influence on the flow problem.

FM-18

Unsteady MHD Free Convective Fluid Flow past a Vertical Cone with Uncertain Parameters

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Abstract: An axisymmetric unsteady MHD free convective boundary layer flow past a vertical cone is considered in fuzzy environment and consequently the initial and boundary conditions along with the parameters involved there are uncertain. Triangular fuzzy number (TFN) is combined with finite difference method (FDM) to solve the fuzzy forms of the non-dimensional governing equations along with the fuzzified dimensionless boundary conditions. $\alpha-$ cut technique is applied to find the solutions by taking $\alpha = 1$, for which we may have results with membership grade 1 with the help of Python (an object oriented computer programming language). Velocity, temperature and concentration distribution are observed under the effects of various involved uncertain parameters.

***Keywords*:** Axisymmetric flow, fuzzy environment, TFN, FDM, $\alpha-$cut technique.

FM-19

Unsteady Hydromagnetic Electrically Conducting Flow Past A Continuously Moving Inclined Plate

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Abstract: An exact analysis of free convection flow of an electrically conducting incompressible fluid over a continuously moving inclined plate embedded on a porous medium is presented. The flow becomes unsteady as the periodic transverse suction velocity is applied to the surface. The visco-elastic fluid flow is characterized by Walters liquid (model B′). Analytical solution of the problem is obtained by using multi-parameter perturbation technique. The expressions for velocity field, temperature field, concentration field, shearing stress at the plate are derived analytically.It is noticed that the momentum and thermal fields are strongly affected in the flow by the visco-elastic parameters. Again, the concentration field is significantly affected in case of Newtonian fluid but not affected by visco-elastic parameter

Keywords: Free convection, Heat source, Hydromagnetic flow, Porous medium, Suction.

FM-20
Mixed Convective Slip Flow and Heat Transfer of Visco-elastic Boundary Layer Flow over a Vertical Plate

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Abstract: The mixed convective heat transfer for visco-elastic boundary layer flow over a vertical plate in presence of velocity and thermal slips at the boundary is investigated. Visco-elastic behaviour of the fluid is exhibited by the non-Newtonian fluid model Walters Liquid (Model $B^{'}$). The fluid motion is governed by a set of coupled non-linear partial differential equations. The governing equations are reduced to ordinary differential equations by employing suitable similarity transformation. The self-similar resultant governing equations along with boundary conditions are numerically solved by in built MATLAB solver 'bvp4c'. The numerically evaluated results of velocity, temperature, temperature gradient and temperature gradient at the plate are represented graphically. The effects of involved parameters in the flow field are illustrated from graphs for discussions to bring out physical insight. The study reveals that the fluid motion and the heat transfer is significantly influenced by the involved flow parameters.

Keywords: Boundary layer, Heat transfer, Mixed convection, Velocity slip, Visco-elastic.

FM-21
Computational Fluid Dynamics and Experimental Analysis of a Corrugated Plate Duct

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Abstract: Enhanced heat transfer is possible in a corrugated plate heat exchanger because of local turbulence created by fluid flow by breaking of laminar sub-layer at lower velocity. Corrugated compact heat exchanger may be used for waste heat utilization from exhaust of a gas engine at variable mass flow rate. Numerical study on heat transfer and fluid flow was conducted on a heated corrugated duct. Experiments were also performed to analyse temperature rise of air in corrugated and plain plate ducts. Numerical results show that Nusselt number, pressure drop and skin friction coefficient decreased with an increase in mass flow rate. From experimental analysis for the corrugated plate, for mass flow rate 0.013 kg/s and 0.05 kg/s, temperature dropped from 438 K to 374 K and 391 K to 361 K. It is found that temperature drop increased by 3.74 % for 0.013 kg/s and 4.43 % for 0.05 kg/s mass flow rate by using corrugated plate. Temperature drop was found 1.33 % for 0.013 kg/s and 0.55 % for 0.05 kg/s mass flow rate for experimental result with respect to numerical result.

Keywords: Corrugated heat exchanger, Nusselt number, Turbulence, Pressure drop, Mass flow rate.

FM-22
Influence of thermal diffusion on an unsteady MHD chemically reactive flow past a vertical porous plate with ramped temperature

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Abstract: Unsteady MHD free convective flow of a viscous, incompressible, electrically conducting and heat absorbing fluid past an infinite vertical porous plate with ramped wall temperature is analyzed in this work with the influence of thermal diffusion and chemical reaction. The flow characteristics are worked out by adopting Laplace Transform technique in closed form. Comprehensive computations of the influence of Soret number and chemical reaction on the variations in the fluid velocity, fluid temperature, fluid concentration, and skin friction, Nusselt number and Sherwood number at the plate are established. Graphical

demonstrations are placed for various values of the physical parameters with their physical relevance. The investigation reveals the fact that thermal diffusion has both enhancing and opposing influence on fluid velocity.

Keywords: Soret number,Chemical reaction, porous medium, Sherwood number

FM-24

Effect of heat and mass transfer on MHD boundary layer flow over a moving surface in presence of thermal radiation and heat generation

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Abstract: The effect of heat and mass transfer on MHD flow from a warm, electrically conducting fluid to melting surface moving parallel to a constant free stream taking into account the effect of heat generation and thermal radiation is studied. The similarity transformation technique is used to convert the partial differential equations into the self-similar ordinary differential equations and then solved numerically using MATLAB BVP solver bvp4c. Solutions for dimensionless velocity field, temperature field and concentration field as well as for the local skin friction parameter, the local heat transfer parameter and the local mass transfer parameter are determined for different values of the governing parameters; mainly the magnetic field parameter, the melting parameter, the heat and mass transfer parameters, the heat generation parameter and the radiation parameter. For some specific values of the governing parameters, the results agree very well with those available in the literature. The numerical values of fluid velocity, temperature and species concentration are displayed graphically whereas the numerical values of skin friction, Nusselt number and Sherwood number are presented in a tabular form for various values of pertinent flow parameters.

Keywords: MHD, Heat and Mass transfer, Thermal radiation, Melting, Heat generation, Moving surface.

FM-25

Effects Of Variable Viscosity and Thermal Conductivity on MHD Free Convective Flow Over A Vertical Porous Plate

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Abstract: This paper investigate the effect of variable viscosity and thermal conductivity on MHD flow over a porous vertical plate .The fluid viscosity and thermal conductivity are assumed to be the inverse linear functions of temperature. The flow governing equations are transformed into ordinary differential equations with the help of similarity substitution. These non-dimensional ordinary differential equations are then solved numerically using MATLAB bvp4c solver. The effects of various parameters viz. magnetic parameter, viscosity parameter, thermal conductivity parameter and heat generation parameter on velocity, temperature and concentration are obtained numerically and presented through graphs. Also the coefficient of skin friction, Nusselt number and Sherwood number are computed and displayed in tabular form.

FM-26

Nonlinear study of variable fluid properties on mixed convection heat and mass transfer flow in a vertical plate with magnetic effects and chemical reaction

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Abstract: Numerical based shooting technique is applied for the study of fluid flow in a vertical plate with magnetic effects and chemical reaction on double diffusive mixed convection with variable fluid properties of permeability, porosity, thermal conductivity and solutal diffusivity is computed. The nonlinear governed partial differential equations involving non –dimensional

parameters like Eckert number, permeability parameter, Reynolds number, Grashof number , Richardson number, magnectic effect, chemical reaction parameter, thermal resistance, are transformed to an ordinary differential equations using special similarity transformation. The computation of nonlinear ODE's for velocity, temperature and concentration are drawn for various values of non-dimensional parameters with variable fluid properties. The results are well agreed with earlier works in the absence of fluid properties and additional effects of double diffusive convection.

FM-27
Solute Transport in Oscillatory Channel Flow with Boundary Absorption: a Numerical Approach

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Abstract: The present study describes a numerical attempt to explore the two-dimensional concentration distribution of solutes released in an incompressible viscous fluid flowing through a channel with first-order reaction walls under the impact of a periodic pressure gradient. The model is based on the unsteady convective-diffusion equation with Dirichlet's and Robin's boundary condition, and whose solution represents the concentration of solutes in different downstream stations. For imposing the boundary conditions properly, *atanh* transformation is used to convert the infinite solution space to a finite one. Using the finite difference implicit scheme which is valid for multi point source, the dispersion process of passive tracer molecules due to purely oscillatory flow and oscillatory flow with non-zero mean have been studied separately. To solve the governing equation in the computational region and an inverse transformation is employed for the solution in the physical region. It is shown that how mixing of the tracer material is influenced by the shear flow and due to the action of the absorption parameter at both the walls of the channel. The results for steady dispersion are compared with existing experimental data available in the literature and we have achieved excellent agreement with them. The study plays a significant role to understand the basic mechanism of sewage dispersion.

Keywords: Channel flow; Numerical scheme; Dispersion; Non-uniform mesh; Absorption

FM-28
Hall and Induced magnetic field effects on convective flow of viscoelastic fluid within an inclined channel with periodic surface conditions

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Abstract: This paper is concerned with the analytical study of the convective flow of a viscoelastic electrically conducting fluid within an inclined channel bounding a porous regime with Hall and induced magnetic field effects. An external magnetic field of high intensity is applied in the direction normal to the inclined surface. The left inclined surface of the channel is considered to be non-magnetic while the right inclined surface is assumed to be magnetized. Suitable non-dimensional transformations are used to reduce the problem to a similar non-dimensional problem. The resulting flow governing equations are solved analytically. The consequences of various flow influencing parameters to the flow variables are numerically computed and presented in graphical and tabular form. It is interesting to note that the growth in angle of inclination reduces the induced magnetic field in the left half of the channel while this effect is opposite in the vicinity of the right inclined surface due to magnetization of this surface.

Keywords: Convective flow, viscoelastic fluid, magnetized surface, Hall current, induced magnetic field.

FM-29

Soret and Dufour effects on stagnation point flow along a vertical stretching sheet with variable physical properties

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Abstract: Aim of the paper is to investigate Soret and Dufour effects on MHD stagnation point flow along a vertical stretching sheet in the presence of magnetic field. The viscosity and thermal conductivity of the fluid are assumed to be varying with respect to temperature. The governing boundary layer equations are formulated and transformed into ordinary coupled differential equations using similarity transformations and which are solved numerically by using Runge-Kutta fourth order scheme with shooting technique. The present results are compared with previously published work and are found to be a very good agreement. The effects of various physical parameters such as viscosity variation parameter, thermal conductivity variation parameter, Soret number, Dufour number, Hartmann number on velocity, temperature and species concentration distributions are presented through graphs. The numerical values of skin friction coefficient, Nusselt number and Sherwood number are obtained, discussed and presented through tables.

Keywords: Soret and Dufour effects, variable viscosity, variable thermal conductivity, shooting technique.

FM-30

Semi-analytical solution of a boundary layer problem for flow past a porous wedge with variable viscosity

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Abstract: Considering the effect of variable viscosity and the phenomenon of flow separation, the flow of fluids past a porous wedge are investigated. The governing partial differential equations are first transformed into a system of non-linear ordinary differential equations using similarity transformations, and later solved analytically by using Adaptive Multi-step Differential Transform Method along with Newton's Method in terms of shooting technique. The velocity and temperature profiles, the skin friction and the rate of heat transfer are computed and discussed for various values of suction/injection parameter, viscosity parameter and Hartree pressure gradient parameter for gases and liquids. It is found that dual solutions exist for negative pressure gradient. In the presence of variable viscosity and suction parameters, the flow separation occurs earlier in gases, while it occurs later in liquids.

Key words: Boundary layer, Variable viscosity, Porous Wedge, Similarity solution, Flow separation.

FM-31

Solute dispersion in a Newtonian blood flow: A layer adapted mesh approach

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Abstract: Analysis of pulsatile blood flow is very effective for the diagnosis of many cardio vascular diseases and for improving pathological patterns in human physiology. The benefit of catheters is of modern importance and has

become the standard tool for diagnosis and treatment in modern medicine. The dispersion process of inert tracer molecules in a pulsatile Newtonian blood flow with or without a non-zero mean through an annulus with absorbing wall is investigated numerically using finite difference implicit scheme with layer adapted meshes. The model is based on unsteady advection-diffusion equation and the solutions are discussed in the form of iso-concentration contours of the tracer molecules in the vertical plane. Concentration profiles for steady-state conditions agree well with existing experimental data and some other available numerical results. It has been shown how tracer propagation is affected by shear flow, aspect ratio and first-order heterogeneous boundary reaction. When the flow becomes convection dominated, the monotone finite difference on a uniform mesh does not work properly, so a layer-adapted mesh namely ``**Shishkin''** mesh is used to capture the layer phenomena at the different downstream stations. It is observed that, due to the use of layer adapted mesh, we have achieved a better agreement with the experimental data than some other previous results available in the literature, especially in the closest downstream location. The results of this study are likely to be of interest to understand the basic mechanism of dispersion process of solute in a Newtonian blood through a catheterized artery with an absorptive arterial wall.

Keywords: Newtonian blood flow; Layer adapted mesh; Finite difference scheme; Dispersion

FM-32
Dynamical Aspect of Blood flow through Stenosed Artery

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Abstract: An attempt is made to investigate the flow of blood through narrow artery with bell shaped stenosis, treating blood as power fluid. The blood is assumed as incompressible and the governing equation is solved analytically. This model has been used to study the influence of applied Magnetic field on axial velocity, flow rate, resistance to flow, shear stress and skin friction has been shown graphically.

Subject Classification: 92B05, 76W05, 92C50, 46N60, 97M10

Keywords: Naviers-Stokes equation, Power fluid equation, skin friction, Non-Newtonian fluid, Shear stress.

FM-33
Study of Solitary Wave Propagation in a Magnetized Dusty Plasma with dust charge fluctuations

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Abstract: The evolution of nonlinear plasma-acoustic wave in a plasma contaminated with dust grains with varying charges under the effect of an external magnetic field is studied. Because of complexity of the ideal plasma model, the derivation of Sagdeev potential equation fails by usual pseudo-potential analysis. By employing a modified mathematical analysis, the nonlinear wave equation has been derived. The proposed mathematical mechanism has shown the success to yield plasma acoustic modes in a dusty plasma which, in turn, has been solved convincingly under small amplitude approximations for solitons and double layers. Numerical analysis has been carried out to the modified Sagdeev potential equation to study the sheath for various plasma parameters. Observations have been evaluated in an appropriate model with a view to agree with the observations in astrophysical problems dealing with present new findings.

FM-34

Influence of Chemical Reaction on an Unsteady MHD Radiative Fluid Flow Past a Vertical Porous Plate with Dufour Effect

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Abstract: Aim of the present study is to investigate the influence of chemical reaction on an unsteady MHD radiative incompressible viscous electrically conducting fluid flow past a vertical porous plate with Dufour effect. The plate moves with a constant velocity in the direction of fluid flow. A uniform magnetic field is applied normal to vertical porous plate. The governing dimensional equations are transformed to non-dimensional form. The resultant equations are then solved analytically by Laplace Transform Technique method. The effects of different flow parameters involved in the problem on velocity, temperature, concentration, skin-friction co-efficient, Nusselt number and Sherwood number are discussed with the help of different graphs. From the graphs results of the problem are found out. It is observed from the graphs that influence of chemical reaction decreases the fluid flow, but fluid flow increases along with the increase in Dufour effect.

Keywords: Chemical reaction, Dufour effect, Laplace Transform Technique, MHD, Porous plate.

TRACK—II

FU-01

Weak Prime Fuzzy Bi-Ideals In Near-Subtraction Semigroups

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Abstract: A study on fuzzy prime ideals in near-subtraction semigroups is already known. Now, we introduce the notation of few new ideal namely, weak prime fuzzy bi-ideals. Further we have to establish the concept and characterize some of its properties.

Key words: Fuzzy Prime ideal, Fuzzy prime bi-ideal, Weak prime fuzzy bi-ideal.

FU-02

Third party entry in a voting problem: A Prisoners' dilemmatic approach in Type-2 intuitionistic fuzzy environment

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Abstract: In a democratic country, 'Voting' is the only way to express the approval or disapproval of governmental policies, plans, programs, and decisions. The political parties make the use of some factors such as political ideologies, political waves, the performance of the ruling party, etc. as the weapon to make sure about winning the ballot-war. A ballot-war has occurred between the ruling party and the strong opposition and for that, they use some strategies. Due to some specific strategies, sometimes the ruling party wins and sometimes the opposition party wins. Again, due to some special strategies,

sometimes a coalition party is formed to rule over the country and sometimes another third party wins the ballot-war. In our present study, we discuss this problem through prisoners' dilemmatic approach under type-2 intuitionistic fuzzy environment. For that, we define a weighted aggregation operator of the type-2 intuitionistic fuzzy set (T2IFS) and a new distance measure of T2IFSs and finally, the problem is solved by utilizing the technique for order of preference by similarity to an ideal solution, i.e., by TOPSIS method and dominance property of matrix game theory.

Keywords: Type-2 intuitionistic fuzzy set, Minkowski distance, Ranking function, TOPSIS, Prisoners' dilemma, Third-party entry in a voting problem.

FU-03

Multicriteria decision making approach using an efficient novel similarity measure for generalized trapezoidal fuzzy numbers

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Abstract: While selecting one best alternative among a set of alternatives based on multiple criteria, Multicriteria Decision Making (MCDM), plays a very important role. Often traditional MCDM process becomes very complex while dealing with uncertainty arising because of vagueness, imprecision, lack of information/data, etc. In an approach to overcomes these critical situations, various types of fuzzy sets are explored and hence, Fuzzy Multicriteria Decision Making (FMCDM) was developed. It is noteworthy that, similarity measure (SM) of generalized fuzzy numbers (GFNs) plays a vital role while selecting the best alternative in FMCDM problems. In this regard, we encounter a wide literature on similarity measures. Although some advantages of these works are noticed, while there also exists certain flaws and counter intuitiveness to most of the approaches. Thus, we have made an attempt to propose a novel similarity measure for generalized trapezoidal fuzzy numbers (GTrFNs). The proposed SM approach however overcomes the impediments associated with the earlier existing approaches and a comparative study of the approaches considered, just affirms that. This paper provides us with an improved method to obtain the similarity values between GTrFNs. The proposed similarity measure consists of calculating the prominent features such as expected value and variance of fuzzy numbers. We use fourteen different sets of GTrFNs, to compare the fruition of the present approach with the existing similarity measure approaches. The efficiency and novelty of the present SM can be very clearly felt and moreover we also consider a FMCDM problem, where the results obtained are at par with analytical output and human intuitions.

FU-04

A novel Pythagorean fuzzy multi-attribute decision making method based on TOPSIS

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Abstract: A Pythagorean fuzzy set (PFS) is a new tool to deal with vague information that occurs in real-world scenarios. It can describe uncertain information more sufficiently and definitively than the intuitionistic fuzzy set. In this paper, we endeavor to find the most preferable solution for MADM problems with the help of Pythagorean fuzzy numbers (PFNs), where the attribute weights are also expressed by PFNs. At First, we define a novel distance measure of Pythagorean fuzzy numbers (PFNs) and discuss their desirable properties. Further, we develop an extended technique for order preference by similarity to ideal solution (TOPSIS) method to deal effectively with them. Then, we propose an algorithm for solving the MADM problem. Finally, we utilize a numerical example to show the validity and flexibility of the proposed method.

Keywords: Pythagorean fuzzy sets, Distance measure, TOPSIS method, MADM.

FU-05

An MCDM method under HFS environment via a novel distance measure on hesitant fuzzy sets

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Abstract: The use of digital equipment is increased in an exponential speed and for this reason the availability of products is also increased in a higher speed. Due to the availability of such products customers get puzzled between several numbers of products and very much dependent upon the reviews of expert's or customers. But unfortunately, sometimes the products are not up to the mark from the perspective of reliability of the product suggested by the reviewers. In this paper, multi-criteria decision making methodology has been utilized to find the reliability of a product considering different features of the product by comparing the review of customer and experts. In addition, a novel distance measure has been defined for hesitant fuzzy sets to eliminate the drawback of normalized, hausdorff and hybrid distance measures. Furthermore, a numerical example is prepared to show the usage of the methodology and the proposed distance measure.

Keywords: Hesitant fuzzy set, fuzzy decision making, distance measure.

FU-06

Defining Probability as a special case of Fuzziness

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Abstract: For many years since the inception of the theory of fuzzy sets authors are trying to establish a link between probability and possibility. The Randomness-Fuzziness Consistency principle is also one such type of relationship which was established recently. In this article, our main intention is to show that a fuzzy number of the type $[\alpha,,]$ or $[\beta,\beta,\gamma]$ can be represented by one probability law. In establishing our claim , we shall take the help of superimposition of uniformly fuzzy intervals and the Randomness-Fuzziness Consistency principle.

Keywords: Superimposition of sets, Randomness-Fuzziness Consistency Principles, Glivenko-Cantelli's theorem.

FU-07

A Novel Mathematical Model of Taxation using Fuzzy Mathematics

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Abstract: Like every year, this year (2020) also the union government (Govt. of India) has declared the annual budget. In it, a major part of the income to the government comes from the income tax levied by the government. This is necessary for the government to continue various developmental works amongst other things. The tax is being levied in a slab wise fashion e.g. tax is exempted for annual income up to Rs. 5 lac, 10% tax for 5-7.5 lac, 30% tax for above 15 lac etc. Because of this, two persons may belong to two adjacent slabs, even though their income might differ only by a small amount. But owing to belonging to different income groups, they will now have to pay very different rate of tax. Thus, there is a non-uniformity in the taxed amount. On top of this, two persons may belong to the same tax slab but can have widely different income. To overcome this, we propose a fuzzy mathematical model approach to levy income tax by the government. This will address both the issues we mentioned, and thereby bringing a uniformity amongst the taxpayers!

Keywords: Mathematical Modelling, Fuzzy Mathematics, Economics, Budget, Income Tax, Taxation.

FU-08

Fuzzified False Position Method and Classical False Position Method: A Comparative Study

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Abstract: Fuzzy logic deals with reasoning that is approximate rather than exact. The concept of "fuzzy logic" was introduced in concurrence with the proposal of fuzzy set theory by Lotfi A. Zadeh in the year 1965. Fuzzy logic has been applied to many fields. Numerical analysis is not about exactness. In case of inexact information, the numerical analyst tries to get a reliable measure of uncertainty which is the outcome of that inexactness and also attempts to acquire an approximation. Considering these facts, in this paper an attempt has been made to fuzzify one popular numerical method viz., False Position method. In this study, the False Position method has been fuzzified using triangular fuzzy number. The fuzzified form has been used to find the solution of a randomly selected set of problems. The results obtained through the fuzzified form of this method have been compared with the respective classical method. For this fuzzified method, computer program has been developed. The number of iterations required to solve a particular problem by the fuzzified method and the classical method are also compared. Before using the statistical test to compare the fuzzified method and the classical method box-plot is constructed and K-S test is used to check the normality of the data. For comparing the results and the number of iterations, paired-t test has been applied and it has been observed that the False Position method provide approximately same results in both the classical and fuzzified form.

Keywords: Fuzzy, False Position method, triangular fuzzy number, box-plot, K-S test, paired-t test.

FU-09

Comparison of Fuzzy Logic, Artificial Neural Networks, Neuro Fuzzy Inference System and Logistic Regression in Predicting the Risk of Infant Mortality

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Abstract: Outcome prediction is a challenging process. It requires quality data and application of proper analytical knowledge. To facilitate this process, various technologies have been developed to produce accurate predicted values. Four models are developed, in this paper, to predict the risk of infant mortality using Fuzzy Logic, Artificial Neural Networks, Neuro Fuzzy Inference System and Logistic Regression. The models are developed on the basis of three independent variables viz.- Birth weight, Mother's age and Mother's Anemiataking real data set from NFHS-III. The area under the receiver operating characteristic (ROC) curve is used to evaluate the performance of fitted models. For modeling and analysis SPSS software is used. At 95% confidence interval, the area under the ROC curve forArtificial Neural Networks is 0.86, Fuzzy Logic is 0.79, Neuro Fuzzy Inference System is 0.61 and Logistic Regression is 0.78. In this study Artificial Neural Networks approach indicates its potentiality in the prediction, planning and assessment of infant mortality over the other three models.

Keywords: Fuzzy Logic, Artificial Neural Networks, Neuro Fuzzy Inference System, Logistic Regression, ROC Curve, Infant mortality.

FU-10

Fuzzy Pre-γ-compact, Fuzzy Pre-γ-connected and Fuzzy Pre-γ-closed Spaces

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Abstract: Compactness and connectedness play a crucial role in Topology. In this paper, we introduce concepts of fuzzy pre-γ-compact, fuzzy pre-γ-connected and fuzzy pre-γ-closed spaces by using concepts of fuzzy pre-γ-open sets. Then we study their properties and compare them .
Keywords and Phrases: Fuzzy pre-γ-open sets, fuzzy pre-γ-compact, fuzzy pre-γ-connected, fuzzy pre-γ-closed spaces.

Subject Classification: 54A05, 54A40, 54D05, 54D30

FU-11

Correlation between Atanassov's Intuitionistic Fuzzy Soft Sets

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Abstract: Correlation is one of the most relevant issues while dealing with data. The correlation coefficient proposed by Karl Pearson in 1895 has become one of the most broadly applied indices in statistics. The notion of correlation is defined on crisp sets and hence it is affected by different generalizations of crisp sets like fuzzy sets and fuzzy soft sets. In this paper, we have introduced correlation between two Attanassov's intuitionistic fuzzy soft sets (A-IFSSs), Attanassov's intuitionistic fuzzy soft points (A-IFSPs). After introducing correlation of A-IFSSs, we study some examples and important properties.

Keywords: Fuzzy soft sets; Intuitionistic fuzzy soft sets; Correlation.

TRACK—III

GA-01

Axiomatization of the Interval Valued Shapley Function on a Class of Cooperative Interval Games with Fuzzy Coalitions

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Abstract: In this paper we introduced fuzzy cooperative interval, interval games with fuzzy coalitions. A set of axioms to characterize the interval valued Shapley function for interval games with fuzzy coalitions is proposed. We introduced a specific expression of the interval valued Shapley function in the class of fuzzy cooperative interval games namely the fuzzy cooperative interval game in Choquet integral form. Finally an example is given.

GA-02

Interval Neutrosophic Einstein Prioritized Normalized Weighted Geometric Bonferroni Mean Operator and its Application to Multicriteria Decision making

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Abstract: Real life decision making problems often involve different priority levels and interaction among the criteria. This paper, combines the prioritized average operator and the normalized weighted geometric Bonferroni mean operator under the Eintein operational rules of interval neutrosophic numbers (INNs) to propose the interval neutrosophic Einstein prioritized normalized weighted geometric Bonferroni mean (INEPNWGBM) operator to deal with the prioritization and correlation

among the criteria in real life decision making problems. Then, some desired properties of the proposed aggregation operator are discussed. Furthermore, an approach to multicriteria decision making based on the Einstein prioritized normalized weighted geometric Bonferroni mean is developed. Finally, a numerical example is provided to illustrate the proposed approach.

Keywords: Interval neutrosophic set; Prioritized aggregation operator; Normilized weighted geometric Bonferroni mean; Multicriteria decision Making.

GA-03
A Constraint based Coalition Formation Game Model for Cooperative Spectrum Sensing in CRNs

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Abstract: In Cognitive Radio Networks (CRN), spectrum holes of Primary User(PU) in a licensed band is identi_ed by Secondary Users (SU) through spectrum sensing techniques. The individual local spectrum sensing of SUs are limited by some factors like noise uncertainty, multi-path fading and shadowing etc. To address such issues, Cooperative Spectrum Sensing (CSS) has been established as a promising method. Here, we have proposed a distributed cooperative spectrum sensing model under the frame work of coalition formation game. The utility of the proposed game is modeled as a trade o_ between cooperation gain and cost. We consider that the Fusion Centre (FC) uses OR decision fusion rule to fuse the sensing information reported by SUs within the coalition. As the number of SUs in the coalition increases the cost of collaboration also increases which limits the utility. A formulation has been proposed to decide the maximum size of the coalition that limits the cost. Adaptive coalition formation takes place through merge and split rule and obtain stability. We also prove that grand coalition will not always form and the proposed game has non-transferable utility. Simulations are carried out to study the performance of the proposed game model.

Keywords: Cooperative Spectrum Sensing, Primary User, Secondary User, Probability of detection, Probability of false alarm, utility, fusion Centre.

GA-04
Game Theory and its Application to Oligopolistic market

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Abstract: In the real world situations, each economic operator faces the rivalries competition by the reaction of his rivals. Hence his decision making depends not only on his own choices but also on the choices of the others. To select an optimal strategy, in the oligopolistic market, decision makers can use game theory. An important contribution in the development of methods for economic analysis has been made by Von Neumann and Oscar Morgenstern which is known as the game theory. Game theory is a mathematical theory that is used for analysis and solving of conflict situations, in which participants have opposite interests. The concepts of game theory provide a tool for formulating, analyzing and understanding different strategies. It attempts to address the functional relationship between the selected strategies of individual players and their market outcome, which may be either profit or loss. The game theory has been applied to the analysis of market situations in which the outcome depends upon the actions of participants with conflicting interests such as duopoly, bilateral monopoly and oligopoly. In this paper try to show how the key aspects of game theory can be used to the equilibrium analysis of Oligopolistic market and how decision makers need to think about the strategic decisions.

Key words: Game theory, oligopoly, optimal strategy, decision makers, equilibrium analysis.

GA-08
Conciliation of marginalism with egalitarianism in networks

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Abstract: In this paper we discuss a player based allocation rule which is a convex combination of the Myerson value and the Equal division allocation rule. This value is more flexible in its nature to choose the level of solidarity according to the situation by varying the value of the constant $\alpha \in [0,1]$, compared to that of the Myerson value and the Equal division allocation rule. We provide four axiomatic characterizations of the value using some axioms which are inspired from cooperative game theory. Further, we formulate a structure for an allocation which satisfies Component Efficiency(CE), Player Anonymity(PA) and Linearity(Lin), i.e., the **CEPAL** value.

GA-09
An Empirical Study on Consumer's Brand Switching Behaviour for the Staple Goods: A Markovian Approach

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Abstract: The motive of this research paper is an attempt to apply the probabilistic methods of Markov Chains to a systematic study of the brand switching behaviour of the customers. The inference of this approach is for developing marketing strategy. The purpose of this paper is to predict the brand switching behaviour of the customers with respect to staple goods. The staple product considered here are rice, tea and toothpaste. This study provides the market share of Rice Brand - Aijung; Tea Brand - Golaghat and Toothpaste Brand– Colgate, in comparison with all the other brands available in Guwahati city, based on Markov chain model. At first, we have to introduce the basic theory of Markov chain model. Secondly, three examples are taken to analyse the market share of rice, tea and toothpaste and Microsoft Excel is used to calculate the numerical solution. By the scientific as well as reasonable information of the market share, it is intended to provide positions to the specific brands of rice, tea and tooth paste accordingly.

Keywords: Markov chain model; Staple product; Market share; Scientific information; Reasonable information.

TRACK—IV

GT-01
Inverse Sum Indeg Index of Trees

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Abstract: Inverse sum indeg (ISI) index of a graph G is the sum of weights $\frac{d_G(u)d_G(v)}{d_G(u)+d_G(v)}$, of all edges uv in G where $d_G(u)$ is the degree of the vertex u in G. This index was selected as a significant predictor of total surface area of octane isomers by Vukičević and Gašperov [6] studied in 2010. In this paper, we establish some results related to ISI index of trees and using those results, we characterize extremal trees on some classes of trees.

Keywords: Inverse sum indeg index, Extremal graphs, Trees.

AMS Classifications (2010): 05C05, 05C07

GT-02
Study of an electrical circuit using nodal analysis and graph theoretic approach

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Abstract: In Mathematics, Graph Theory is a branch where we study about some points or nodes and the defined connections among the points. In electrical circuit, electrical elements are connected in a particular way for passing current. An electrical circuit consists of nodes and branches which obeys the current laws such as Kirchhoff's Current Law, Kirchhoff's Voltage Law etc. The circuits can be simplified by using many well known theorems of Electrical Engineering. The same process can be done with the help of Graph Theory and matrices also. From circuits we can find matrices by different rules. There are different matrices such as branch impedance matrix, branch admittance matrix, tie-set matrix etc which can be obtained from electrical circuits. In this paper we shall try to analyse some circuits with the help of graph theory and nodal analysis of electrical circuits. The main objective of this paper is to study about branch current and loop current with the help of graph theory through matrix equilibrium equations obtained from current laws.

Keywords: Graph Theory, Electrical Circuits, Tie-set matrix, Branch current, Loop current.

GT-03
Some results on solvable graphs of finite groups

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Abstract: Let G be a finite non-solvable group with solvable radical Sol(G) ={u∈G :$< u,v >$is solvable for all v ∈ G}. The solvable graph $\Gamma_s(G)$ of G is a graph with vertex set G\ Sol(G) and two distinct vertices u and v are adjacent ifand only if $< u,v >$is solvable. We show that $\Gamma_s(G)$ is not a star graph, a tree,an n-partite graph for any positive integer n ≥ 2 and not a regular graph forany non-solvable finite group G. We prove the non-existence of finite non-solvable groups whose solvable graphs are planar, toroidal, double-toroidal ortriple-toroidal. The solvability degree of a finite group G is defined by the ratio

$$P_{s(G)} = \frac{|\{(u,v) \in G \times G: < u,v > issolvavle\}|}{|G|^2}$$

In this paper, we also obtain a relation between $\Gamma_s(G)$ and $P_s(G)$. The results of this paper are accepted for publication in Hacettepe Journal of Mathematics and Statistics.

GT-04
Tadpole graphs and their laceability

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Abstract: A connected graph G is termed Hamiltonian-t-laceable (t*-laceable) if there exists in G a Hamiltonian path between every pair (at least one pair) of its vertices u and v with the property d(u,v) = t. The Tadpole graph

is the graph obtained by joining a cycle graph *Cm* to a path graph *Pn* with a bridge. In this paper, we discuss the laceability properties associated with the Tadpole graph.

Keywords: Hamiltonian-t-laceability, Hamiltonian-t*-laceability, Tadpole graph

GT-05
Computation of Generalized Topological Indices of Some Special Graphs

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Abstract: There are several topological indices that have been introduced in theoretical chemistry to measure the properties of chemical compounds, based on various parameters such as distance-based topological indices, degree-based topological indices etc. Among these topological indices generalized topological indices have also some important significance. Some physicochemical properties such as the boiling point, stability and strain energy, of chemical compounds are correlated by these topological indices. In this work, we compute the generalized topological indices of some special type of graphs such as Cayley tree graph, Square lattice graph and Complete Bipartite graph.

Keywords: Topological index, Generalized topological indices, Cayley tree graph, Square lattice graph, Complete Bipartite graph.

AMS Mathematics Subject Classification (2010): 05C05, 05C07, 05C35

GT-07
On the Zagreb Spectrum of Edge Corona Networks

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Abstract: In this work, we study the weighted edge corona networks and use it in terms of one of the most popular topological indices, viz, the Zagreb indices. The Zagreb spectra with respect to two different structures are obtained. We also compute the Zagreb spectra of two different structures with one of them being a bipartite graph.

Key words: Zagreb indices, edge corona network, graph spectra.

AMS Classifications (2010): 05C05, 05C07

GT-08
A Preliminary Survey on Effective Graph Resistance

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Abstract: The effective graph resistance is a graph measure with its origin from the field of electrical circuit analysis. For a connected graph it is defined as the sum of effective resistance between all vertex pairs, assuming that the graph is an electrical circuit where the resistance between adjacent vertices is unity. It can be obtained in terms of non-zero eigen values of the associated Laplacian matrix. In this paper a survey on the known results of effective graph resistance is done and its applications mainly as a robustness measure are discussed. Further, the recent works on the measure and its future scopes are analyzed.

Keywords: Effective resistance, Laplacian eigen values, Graph spectrum.

AMS Classifications (2010): 05C50, 94C05, 94C15

GT-09
On the applications of ISIS index to octane isomers and benzenoid hydrocarbons

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Abstract: The classical inverse sum indeg (*ISI*) index is utilized as a predictor of total surface area of octane isomers.If for a graph G, $E(G)$ represents the edge set and $d_G(u)$ represents the degree of vertex u of Gthen,*ISI* index of Gcan be defined as $ISI(G) = \sum_{uv \in E(G)} \frac{d_G(u)d_G(v)}{d_G(u)+d_G(v)}$ .In this work, a modified version of *ISI* index is discussed along with its correlations with various physicochemical properties of octane isomers and benzenoid hydrocarbons.

Keywords: Degree, Distance, Status, Topological Index, ISI index

AMS Classifications (2010): 05C05, 05C07, 05C12, 05C90.

GT-10
Equitable Integrity in Graphs

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Abstract: The concept of degree equitable sets was first introduced and studied by S. Arumugam et al. Let $G = (V,E)$ be a simple graph. A subset $S \in V(G)$ is a said to be degree equitable set if the degrees of any two nodes in S differ by at most one. (i.e.) $|d(u)–d(v)| \leq 1, u,v \in S$. In this paper, we introduce a new vulnerability parameter called equitable integrity. The equitable integrity of graph G which is defined as $EQI(G) = min\{|S| + m(G - S) : S$ is a degree equitable set of $G\}$, where $m(G - S)$ denotes the order of the largest component in $G - S$. In this work, we study the concepts of equitable integrity of some standard graphs and discuss the upper and lower bounds on the equitable integrity. Andal so we apply equitable integrity on sewer network system and water distribution system and analyze the vulnerability of these system.

Keywords: Degree equitable sets, Equitable integrity, Sewer network, Water distribution system.

GT-11
On Adjacency and Seidel polynomial of Splice and Link of certain graphs

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Abstract: The adjacency and Seidel polynomial of a graph is the respective characteristic polynomial of adjacency matrix and Seidel matrix. Adjacency polynomial of splice and link graphs of some well known graph classes have been obtained recently in the literature. In this article we study the adjacency polynomial of the complement of splice and link graphs of certain graphs and also Seidel polynomial by using the concept of equitable partition.

Keywords: Adjacency polynomial, Seidel polynomial, Splice, Link, Equitable partition.

GT-12
A survey of some recent results of *ST*-Coloring of Graphs

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Abstract: A *Strong T-coloring* of a graph G is a function $f : V(G) \to Z^+ \cup \{0\}$ such that for all $u \neq w$ in $V(G)$, $(u,w) \in E(G)$ then $|f(u) - f(w)| \notin T$ and $|f(u) - f(w)| \neq |f(x) - f(y)|$ for any two distinct edges (u,w) and (x,y) in $E(G)$, where T be any finite set of non-negative integers. The minimum number of colors needed for a Strong T *coloring* of a graph is known as *ST-Chromatic number*. For a *ST-coloring, c,* the c_{ST}*-span* $sp^c_{ST}(G)$is the maximum value $|c(u) - c(w)|$ over all the vertices and the minimum of sp^c_{ST} (G) is known as $sp_{ST}(G)$. The c_{ST}*-edgespan* $esp^c_{ST}(G)$is the maximum value $|c(u) - c(w)|$ over all the edges (u,w) and the minimum of esp^c_{ST} (G) is known as $esp_{ST}(G)$, where the minimum is taken over all *ST-coloring c* of G. Here, we discuss some of the results related to ST-chromatic number of various graphs, $sp^c_{ST}(G)$, $esp^c_{ST}(G)$ of graphs.

Keywords: T-coloring, ST-coloring, ST-chromatic number, span, edge span.

AMS subject classification: 05C15

GT-13
On energy of matrices of a weighted graph

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Abstract: In 1978, Gutman introduced the concept of energy of a graph as the sum of the absolute values of the eigenvalues of adjacency matrix of the graph. Later, energies of different graph matrices, such as Laplacian matrix, signless Laplacian matrix, Randic matrix, etc. have been studied by many researchers. In 2007, Nikiforov extended the notion of energy to any rectangular matrix as the sum of singular values of the matix. In particular, the energy of a square matrix is the sum of absolute deviations of its eigenvalues from their mean. We consider a real symmetric matrix $\hat{A}$ with zero diagonals which represent the adjacency matrix of a weighted graph. Considering the sum of weights of edges incident to a vertex as the weight of the corresponding vertex, we construct the diagonal matrix $\hat{D}$ whose diagonal entries are the weights of the corresponding vertices. Then we define the weighted versions of Laplacian and signless Laplacian matrices as $\hat{L} = \hat{D} - \hat{A}$ and $\hat{Q} = \hat{D} + \hat{A}$.

In this paper, we obtain a bound of energy of weighted adjacency matrix $\hat{A}$ which generalizes imilar result for unweighted graph. Also we obtain some inequalities involving the energies of weighted adjacency matrix, weighted Laplacian matrix and weighted signless Laplacian matrix. Finally, we obtain some inequalities involving energies of those

three matrices of a weighted graph and those of an induced subgraph of it.

Keywords: Energy, weighted graph, weighted adjacency matrix, Laplacian matrix, signless Laplacian matrix.
MSC (2010): Primary: 05C50; Secondary: 05C35.

GT-14
Application of Graph Semirings in Decision Networks

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Abstract: Graphs satisfying some algebraic properties leading to the introduction of the rules of semiring for the analysis of decision problems are briey discussed. We illustrate some examples of the networks of graphs (where the vertices of the given network are again graphs), and use the rules of semirings for their analysis. In this article, we use graph operations, namely union and intersection as a semiring addition and multiplication, respectively where the set forming the semiring is a set of undirected graphs. The article leaves with an impression that such notions may be helpful in handling routing problems or, in joining the different networks.

GT-15
Idempotent graph of $\mathbb{Z}_n$

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Abstract: We introduce the idempotent graph of a ring R, denoted by $I(\Gamma(R))$, as the (undirected) graph with all elements of R as vertices, and for distinct $x,y \in R$, the vertices x and y are adjacent if and only if $x+y \in I(\Gamma(R))$. The set Idem(R) denotes the set of idempotent element of R. In this paper, we have obtained some graph theoretic properties of $\mathbb{Z}_n$ like girth, clique, diameter etc. Also we determined condition when the graph is planar and found the independent number for some particular cases of n.
Keywords: Idempotent, Clique, radius, diameter.
Mathematics Subject Classification(2010): 13AXX, 05CXX.

GT-16
Domination number of prime intersection graph of ideals of a ring

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Abstract: The prime intersection graph of ideals of a ring R is simple graph, denoted by G_P (R), whose vertex set is the collection of all non-trivial (left) ideals of R. Two disdinct ideals I and J are adjacent in G_P (R) if and only if $I \cap J \neq 0$ and either one of I or J is a prime ideal of R. In this article, we characterize the intersection graph of ideals of ring having domination number one and two. First we determine the domination number in the graph of G_P ($\mathbb{Z}_n$) and then proceeds for the same for G_P (R).

Keywords: Intersection graphs; Domination number.

Mathematics Subject Classification(2010): 13AXX, 05CXX.

GT-17
On Colourability of Hypergraphs

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Abstract: In this paper we deal with some kind of deletion contraction property in connection with a hypergraph, leading to certain types of structure theorem of a hypergraph. Keeping at par with the fundamental theorem relating to alternating monic chromatic polynomial, we attempt to give an elegant algorithmic description of the theorem, finally coinciding with the graph theoretic fundamental version. The decomposition theorem on alternating monic chromatic polynomials in turn, leads us to an elegant quotient structure. In case of r-uniform q-edge tree hypergraphs we derive a factorisation structure of strongly chromatic polynomials and weakly chromatic polynomials. Though, here we meet an unsolved question "What is the necessary and sufficient condition to have the same chromatic polynomial?", we observe an interesting result of two q-edge r-uniform hypergraphs. In case of r-uniform q-edge tree hypergraphs we obtain factorisations of strongly chromatic polynomials and weakly chromatic polynomials leading to equivalence of these.

GT-18
On the Generalized ISI Energy of Thorn Graphs

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Abstract: For a simple connected graph $G = (V,E)$, the generalized ISI index is defined as $ISI_{(\alpha,\beta)}(G) = \sum_{v_iv_j \in E(G)} (d_id_j)^{\alpha}(d_i + d_j)^{\beta}$, where, d_i represents the degree of the vertex v_i in $V(G)$ and α and β are some real numbers. In this paper, we have proposed the generalized ISI matrix in connection with this index and computed the generalized ISI energy of thorn graphs and several special cases are examined. Results are used to compute generalized ISI energy of thorn paths, thorn rods and caterpillars.

Keywords: Energy of a graph, generalized ISI energy, thorn graph.

AMS Classification (2010): 05C50, 92E10

GT-19
First KCD energy of a graph

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Abstract: In this article we introduce the concept of first Karnatak College, Dharwad matrix of a graph G i.e., $KCD_1(G)$ and related energy of a graph G. Further, computation of first KCD polynomial of some graphs, bounds for the largest first KCD eigenvalue and first KCD energy of graphs is determined in this article.

Keywords: First KCD matrix, first KCD polynomial, eigenvalues, first KCD energy.

Mathematical Subject Classification 2010: 05C07, 05C50.

GT-20
On the bounds and energy of block adjacency matrix for some class of graphs

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Abstract: The energy of the graph is de_ned as the sum of the absolute values of the eigen-values of its adjacency matrix. In this article the block adjacency matrix BA(G) is in-troduced. The results are established on energy

and spectra of block adjacency of matrix. Further we obtained the bounds for eigenvalues and energy for block adjacency energy of graph.

Keywords: Block adjacency of matrix, Eigenvalues, Energy of a graph, Spectrum of a graph.

2010 Mathematics Subject Classification : 05C05, 05C50.

GT-21

A Remark on Amino Acids Network Analysis: Signed Graph Approach

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Abstract: In the process of protein evaluation, if two amino acids have more similar common properties the chance of substitution or mutation occurs between them will increase with decrease in physico-chemical distance. Again, if two amino acids have more common properties they will be structurally more similar and hence they will have always a tendency to evolve in to another in the process of evolution. There are 20 amino acids found till now in protein and each of them has different physico-chemical properties due to the variation in the structure of R group. Here in this manuscripts we have applied the signed graph approach to study the evolution of amino acids and hence the protein structure. At last, from the balance property of signed graph we give a conclusion for evolution of amino acids.

GT-22

Some Aspects of Γ_2 Graph Over The Ring of Gaussian Integers Modulo n :

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Abstract: This paper is focussed on some properties of a special type of graph called the Γ_2 graph which was first introduced by R. Sengupta. Let R be a ring then Γ_2 is an undirected graph (V;E) in which $V = R\backslash\{0\}$ and for any $a,b \in V$, $ab \in E$ if and only if $a \neq b$ and either a.b = 0 or b.a = 0 or a + b is a zero-divisor (including 0). However, Sengupta mainly considered the Γ_2 graph paying attention to Zn . We have tried to work on further with the ring of Gaussian integers modulo n and try to generalize the structure of this graph for different prime power factorizations of n. The connectedness and other properties like diameter, girth, chromatic number, completeness of these graphs are also determined in our work.

Keywords: Bipartite graph, Complete graph, Ideal, Gaussian integers, Diameter, girth.

GT-23

Study of spectral graph theory in application to image processing using surf algorithm

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Abstract: Spectral graph theory is a mathematical theory where linear algebra and graph theory meet together. In this theory, graphs are studied by means of Eigenvalues of a matrix associated with the graph via Adjacency Matrix, Incidence Matrix, Laplacian Matrix etc. A digital image in a computer is presented by pixels matrix. Each image processing operation in a computer may be observed as an operation on the image matrix. In this paper, we study the use of SURF (Speeded Up Robust Features) to detect a segment of an image from a particular image. The main objective is to discuss the role of Eigenvalues and Eigenvectors in image detection and the use of SURF based face recognition.

Keywords: Graph Theory, Graph Spectra, SURF, Image

GT-24

Complement of iterated line graphs with only negative eigenvalues-2 and their energy

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Abstract: The important spectral property of line graph is that its least eigenvalue is at least-2. The problem of particular interest in this class of graphs is the line graphs with all negative eigenvalues equal to- 2. In this paper, several results on complements of iterated line graphs having all negative eigenvalues equal to-2 and their energy are presented. Also we have characterized large class of equienergetic graphs.

Keywords: Energy, Iterated line graphs and Complement of iterated line graphs.

Subject Classification: 05C50.

GT-25

A linear time algorithm for minimum equitable dominating set in trees

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Abstract: Let G = (V;E) be a graph. A subset D^e of V is said to be an equitable dominating set if for every $v \in V \backslash D^e$ there exists $u \in D^e$ such that $uv \in E$ and $|\deg(u) - \deg(v)| \leq 1$, where, deg(u) and deg(v) denote the degree of the vertices u and v respectively. An equitable dominating set with minimum cardinality is called the minimum equitable dominating set and its cardinality is called the equitable domination number and it is denoted by γ^e. The problem of finding minimum equitable dominating set in general graphs is NP-complete. In this paper, we give a linear time algorithm to determine minimum equitable dominating set of a tree.

Keywords: Equitable domination, linear time algorithm, trees.

GT-26

On Degree-based Topological indices of SnO_2 Crystal via M-polynomial

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Abstract: Topological indices of a molecular graph are very much useful to study various physico-chemical properties, to develop quantitative structure-property relationship (QSPR) and quantitative structure-activity relationship (QSAR) of chemical compound. To calculate topological indices of a graph various techniques have been developed. Recently a technique of calculating degree-based topological indices from M-polynomial has been introduced. We have constructed the M-polynomial and then calculated some degree based topological indices of 3D SnO_2 crystal. The topological indices are expressed in terms of three variables m, n and t. These variables help us to understand the growth of SnO_2 crystal in 1-D, 2-D and 3-D respectively. Finally, an attempt has been made to study the variations of topological indices with m, n and t.

Keywords: Molecular graph, Topological Index, M-polynomial, Crystal, SnO_2.

GT-27
A note on total graph of a finite commutative ring

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Abstract: The total graph has been defined by Anderson and Badawi [1] as an undirected graph with all elements of a finite commutative ring R with unity as vertices and for distinct elements x and y in R, x is adjacent to y whenever x + y belongs to the set of Z(R), the set of zero divisors of R and this graph is denoted by T(Γ(R)). Many mathematicians have derived properties of the total graph of a ring. In this paper, we find the crossing number of all local rings with some bounds in the cardinality of zero divisors. We determine matching, factors and arboricity of the total graph of a ring. We find the independence number of the line graph of the total graph of a ring and give complete characterization of rings for which diam L(T(Γ (R))) =, < or > diam T(Γ (R)).

Keywords: Crossing number, Zero divisors, Matching, Factors, Arboricity.

GT-28
A preliminary study on spectra of Zagreb Matrix and Zagreb-Laplacian Matrix of Edge Corona Networks

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Abstract: In this work, we study the edge corona networks and utilise it in terms of one of the most popular topological indices, viz., the Zagreb indices. The Zagreb spectra in terms of Laplacian spectrum with respect to two different structures are obtained. We also compute the Zagreb spectra of two different structures in terms of adjacency spectrum.

Keywords: Zagreb indices, edge corona network, graphspectra.

AMS Classifications (2010): 05C05, 05C07

GT-29
Degree product adjacency energies of complement of regular graphs and complement of line graphs of regular graphs

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Abstract: Let G be a simple graph with n vertices, if $\alpha_1, \alpha_2, \ldots, \alpha_k$ be the eigenvalues of degree product adjacency matrix of graph G, then degree product adjacency energy of G is

$$E_{DPA}(G) = \sum_{i=1}^{k} |\alpha_i|$$

In this article, we find the explicit formulas for the degree product adjacency energy of the complement graph of a r regular graph and also the degree product adjacency energy of $\overline{L(G)}$ complement of a line graph of G. In this way one can calculate/compute the degree product adjacency energy of large family of regular graphs.

Keywords: Degree product adjacency energy, spectrum of a graph, complement of a graph, line graph.

Mathematical Subject Classification 2010: 05C05, 05C50.

TRACK--V

MI-01
Upper bounds of numerical range and numerical radius of operator matrices involved in two-parameter eigen value problems

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Abstract: In this paper, linear two-parameter eigenvalue problems in terms of matrix operators are considered. Generally for spectral analysis, two-parameter problem is reduced into a system of generalized eigenvalue problem using a special pair of determinantal matrices on tensor product space. Many classical results and methods for the study of these problems are based on this special pair of matrices. In this work, some upper bounds on numerical range and numerical radius of the special pair of operator matrices arising from two-parameter problem will be derived.

AMS Subject Classifications: 15A60, 47A12, 47A75 (2020).

Key Words : Numerical range, Numerical radius, Two-parameter eigenvalue problem.

MI-02
The Balakrishnan-Alpha-Beta-Skew-Logistic Distribution: Properties and Applications

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Abstract: In this paper, a new form of alpha-beta-skew Logistic distribution of Shah and Hazarika (2019) is proposed under Balakrishnan (2002) mechanism and investigated some of its related distributions. The moments, distributional properties and some extensions of the proposed distribution have also studied. Finally, the suitability and the applicability of the proposed distribution has tested by conducting data fitting experiment and comparing the values of Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) with the values of some other related distributions. Likelihood Ratio testis used for discriminating between Logistic and the proposed distributions.

Keywords: Skew Distribution, Balakrishnan Alpha Skew Logistic Distribution, Bimodal Distribution, Likelihood Ratio Test, AIC, BIC

MI-03
Fractional Order Explicit Approximation For Time Fractional Radon Diffusion Equation And Analytical Estimates Of Radon Diffusion In Air

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Abstract: In this paper we present the holistic analysis for the explicit difference approximation for time fractional diffusion equation for radon gas in air medium. The equation also includes

the decays of radon diffusion and talks about the concentration of radon as function of space and time in air medium. The parameters analysed related to diffusion of radon in air and the concentrations works out for the geometry adopted for analytical investigations. The discussion on stability and convergence extensively verify the solution obtained for diffusion equation .Validation of the solution is carried out with the help of graphical illustration using 'Mathematica' software. Valid numerical results are evident for the diffusion equation under investigation. The process of radon transport through a cylinder of air is studied. The study of the fractional order explicit finite difference scheme for time fractional radon diffusion equation is highly effective and its efficacy is undoubted. The investigation of the method leads to the conclusion that the numerical outcomes are conforming the hypothetical investigation. It is observed that the fractional order explicit finite difference method is numerically conditionally stable.

Keywords: Time fractional differential equation, Caputo fractional derivative, diffusion equation, Explicit method stability convergence

2010 AMS Classifications: 35R10 Partial functional-differential equations; 65M06 Finite difference methods

MI-04
Study of Bounds for the Order of the Group of Automorphisms of compact Riemann surface With Reference to the point group of Carbon Tetrachloride

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Abstract: A finite group G acts as a group of automorphisms on a compact Riemann surface S of genus g if and only if there exist a Fuchsian group Γ and an epimorphism $\phi:\Gamma \to G$ such that $ker\phi = K$ is a surface group of genus g. And then ϕ is named as smooth homomorphism. Whenever the smooth epimorphism exist we can calculate the minimum value of g, the genus of the surface as well as the associate Fuchian group. The objective of this paper is to obtain the upper bound $6(g-1)$ of the compact Riemann surface with reference to the finite group of symmetries of Carbon Tetra chloride molecule, whose abstract group representation is $\langle a,b|a^4 = b^3 = (ab)^2\rangle$ and associate Fuchsian group is [2,2,3,3].

Key words: - compact Riemann surface, group of automorphisms. genus, smooth epimorphism, point group.

AMS Mathematics Subject Classification 2020: 20B25, 20B30, 20H10, 30F10.

MI-05
Some Results On Entropy in Bitopological Space

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Abstract: In this paper we shall discuss some results on entropy in bitopological space from the perspective of bitopological dynamical systems [1].

References:

1. Acharjee S, Goswami K, Sarmah HK. On entropy in bitopological dynamical systems. (Communicated).

MI-06
The Continuous Quaternion Wavelet Transform on Sobolev Spaces

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Abstract: In this paper, the Sobolev spaces $H^s(\mathbb{R}^2;\mathbb{H})$ and $W^{m,p}(\Omega,\mathbb{H})$, weighted Sobolev space $W_k^{m,p}(\Omega;\mathbb{H})$ and generalized Sobolev space $H_w^{\omega}(\mathbb{R}^2;\mathbb{H})$ are defined for

quaternion-valued functions. The continuous quaternion wavelet transform (CQWT) is studied on these spaces and obtained some new continuity and boundedness results.

MI-07
Coxeter Dihedral Symmetric Tetrahedrons with Spherical and Hyperbolic Triangle Groups

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Abstract: In this article, we have studied about the gram matrices, and their associated gram spectrums of symmetric and regular tetrahedrons with the triangle groups-Spherical and Hyperbolic. We have also classified the Coxeter Dihedral Symmetric (CDS) tetrahedrons with triangle groups-Spherical and Hyperbolic. And finally calculated the gram spectrums of CDS tetrahedrons with triangle groups-Spherical and Hyperbolic.

MI-08
Neimark-Sacker bifurcation in a two dimensional nonlinear map

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Abstract: The purpose of this paper is to investigate the Neimark-Sacker bifurcation in a two dimensional nonlinear map $F(x,y) = (y, ay + b - x^2)$, where a and b are real parameters. In Neimark-Sacker bifurcation, the fixed point gets converted to a unit circle. In case of our considered map, we observed the emergence of quasiperiodic and mode-locked states near Neimark-Sacker bifurcation point. Using the analytical technique of Normal form, we have determined the mode locked state in the vicinity of the NS bifurcation point. We have also used numerical tools like final state diagram, Lyapunov exponent, phase portrait and time series plot to establish the transition from periodic to quasiperiodic through mode locked state and finally to chaotic state

Keywords: Neimark-Sacker bifurcation, normal form

MI-09
A Hyperbolic based approach of distance and similarity measure

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Abstract: The concept of Hyperbolic fuzzy set (HFS) is very useful in decision making process due to its indeterminacy. The concept of Pythagorean fuzzy set (PFS) has been nearly invincible due to its advantages over Intuitionistic fuzzy set (IFS). But Pythagorean fuzzy set is also not free of shortcomings. The main advantage of using Hyperbolic fuzzy set is that it solves the limitations of Pythagorean fuzzy sets. It is seen that there are some limitations in Hamming and Euclidean distance and similarity measures using Pythagorean fuzzy set which can be solved by using Hyperbolic fuzzy set. Examples are given which will show the validity of this concept and its applicability in various multi-criteria decision making problems (MCDMP) and multi-attribute decision making problems (MADMP), respectively.

MI-10
Domain of Riesz difference operator of fractional order in ℓ_p space

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Abstract. Let $\Gamma(x)$ denotes the gamma function of a real number $x \notin \{0, -1, -2, ...\}$. Then the difference operator Δ^{Bq} of fractional order q is defined as

$$\left(\Delta^{Bq} v\right)_i = \sum_{l=0}^{\infty} (-1)^l \frac{\Gamma(q+1)}{l!\Gamma(q-l+1)} v_{i-l}.$$

In this paper we introduce Riesz difference sequence space $r_p^t(\Delta^{Bq})$ of fractional order q obtained by the domain of generalized difference operator $R^t\Delta^{Bq}$ in ℓ_p space. We investigate

certain topological properties, obtain the Schauder basis, $\alpha-$, $\beta-$ and $\gamma-$duals of the new space. Finally, using Hausdorff measure of non-compactness, we characterize certain classes of compact operators on the space $r_p^t(\Delta^{Bq})$.

Keywords: Riesz matrix, Backward fractional difference operator Δ^{Bq}, $\alpha-$, $\beta-$ and $\gamma-$duals, Compact operators, Hausdorff measure of non-compactness.

AMS Subject Classification (2010): 46A45, 46B45, 47B07.

MI-11
On Identities for basic Hypergeometric Series Through Wp-Bailey's Pairs

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Abstract: Transformation theory play very important role in the theory of q-hypergeometric series. In this paper, a number of new q-basic series established through employing well known summation identities and WP-Bailey's pairs.

MI-12
One Inflated Distribution and its Application

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Abstract: In some sampling including non-negative integer, such as zero, one, two are observed with very high frequency and the models generate to this type of frequencies are called inflated models. In this paper Ono-inflated Binomial distribution is considered along with some of its structural properties and estimation of its parameters using the method of maximum likelihood estimators. A real life example is provided to compare with the other existing models.

MI-13
Study of Number Conserving Cellular Automata Rules through Integral Value Transformations

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Abstract: In this paper, the connection between two Discrete Dynamical Systems over binary strings called Cellular Automata (CA) and Integral Value Transformations (IVTs) based on their space-time diagram has been established. A new class of IVTs called number conserving IVTs (NCIVTs) having similarity with number conserving CA (NCCA) rules has been identified. The cardinality of rule space for uniform IVTs, non-uniform IVTs and non-uniform IVTs which may vary over time has been calculated for one and higher dimensions. It has been established that these NCIVTs belong to a space of exponential cardinality and their construction mechanisms are discussed. For application point of view, some interesting patterns have been generated with the application of such IVTs.

MI-14
N-Gram Language Model in Identification of *Raaga* for *Borgeets*

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Abstract: *Raaga* is the remarkable and central feature of the Indian classical music tradition including *Sankari-Sangeet*. Each *Raaga* is an amalgamation or arrangement of musical notes

which altogether constitute an array of melodic structures with musical motifs that has the ability to "colour the mind" and affect the emotions of the audience. It is a very difficult as well as essential skill that enables the listeners to recognize the *raaga*. All types of music composed by Shrimanta Sankardev and his most prominent disciple Scrimanta Madhavdev are commonly known as *Sankari Sangeet or Mohapuruxia Sangeet*. In the musical hierarchy of *Sankari Sangeet*, *Borgeet* occupies the highest position. One of the bases of classifying the *Borgeets* is by identifying the *Raaga* used to compose them. In this paper, a computational approach is presented which is found to be a successful technique for identifying the *raaga* of *Borgeets*. The technique is based on N-gram language model. Identification of the *raaga* of a particular *borgeet* is done with the help of Perplexity value calculated from the bi-gram note transitions of that *borgeet* and the information available from the *raaganga (Pakad)* of different *raagas* of *Mohapuruxia Sangeet*.

Keywords: *Raaga, Raaganga, Markov Model, N-gram.*

MI-15
Generalized holographic dark energy model and accelerating universe

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Abstract: The aim of this study is to discuss the evolution of holographic dark energy in higher derivative gravity assuming gravitational constant G and the model parameter c2 of dark energy, as time varying function. Since dark energy emerges as combined effect of linear as well as non-linear terms of curvature, therefore it is important to see holographic dark energy at higher derivative gravity where action contains both linear as well as non-linear terms of Ricci curvature R. Considering the non-interacting scenario of holographic dark energy with dark matter in spatially flat universe, we obtain, the equation of state parameter and extract the exact differential equations, to explain the evolution of holographic dark energy, which contains both G and c2 variation correction terms. We obtain that varying G and c2 in holographic dark energy, replicate the role of Phantom dark energy model. Also, we determine the deceleration parameter to explain the expansion of the universe. Further, we investigate the validity of the generalized second law of thermodynamics in this scenario. Finally, for low red-shift expansion of the dark energy equation of state, we find out involved parameters which contains current density parameters together with varying G and c2 parameter corrections. In our work, by generalized holographic dark energy (GHDE), we mean holographic dark energy with time varying G as well as c2 parameter.

MI-16
A Study Of Fractional S-Transform On Sobolev Spaces

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Abstract: In this paper, some boundedness and continuity results for fractional S-transform on Sobolev space and weighted Sobolev space is investigated. Some results are observed and investigated in these spaces.

MI-17
Existence and uniqueness of solutions for a class of Caputo-type fractional initial value problem

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Abstract: In the present paper we give sufficient conditions for the existence and uniqueness of the solution for a class of fractional initial value problem involving the Caputo-type fractional derivative of Saigo's integral operator. Our analysis relies on the Banach contraction mapping principle, Schauder fixed point theorem and nonlinear alternative of Leray-Schauder. Some examples are included to show the applicability of our results.

Keywords: Fractional derivatives and integrals, Fractional differential equation, Fixed point theorems, Nonlinear Alternative.

2010 MSC No: 26A33, 34A12, 45D05, 47H10.

MI-18
A study of weak sloution on a class of fractional differential equation

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Abstract: In the present paper we focus on the existence theorem for weak solution for a class of Caputo fractional differential equation together with initial condition in continuous function space using Monchs fixed point theorem associated with the technique of measure of weak compactness. Further the existence result of weak solution is extended in L_2 space using Arzela-Ascoli theorem which is discussed.

Keywords: Fractional derivatives and integrals, Fractional differential equation, Caputo derivative, Weak solution

MI-19
A note on D4 and D2 Modules

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Abstract: Let M be a left R-module.We show the equivalence of D4 and D2 condition of M in terms of finite exchange property. We also prove that D4 and D2 condition of M is equivalent if End $R(M)$ has unique prime ideal. Besides these, we also find many conditions under which D4 module is equivalent to D2 module.

MI-20
A comparative study on fractional derivative masks for edge detection analysis

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Abstract: Quantitative design and performance of edge detection is an essential stage in numerous image processing applications. Due to the extra free parameter order α, fractional order based methods provide additional degree of freedom in optimization performance of the technique. This work presents a comparative study of fractional order edge detection with Gradient order edge detectors, when applied to three types of images, i) Linear image; ii) Non-linear image. Further the study will be extending to compare the Fractional derivative edge detectors, applied to the above mentioned imagesfor different order of the derivative ranging from 1-2.

MI-21
Cassini's identity and its generalization

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Abstract: Cassini's identity can be expressed in terms of determinant of 2 x 2 matrix involving Fibonacci numbers. In this paper, we generalize the identity in terms of determinant of n x n matrix involving numbers from sequences generated in Fibonacci pattern. (n-1) sequences are generated by adding two latest terms from the previous sequence. Each term in any of the sequences can be obtained by a recurrence relation involving binomial coefficients. This relation is then used to obtain an identity which is a generalization of Cassini's identity.

Keywords: Fibonacci sequence; Cassini's identity.

TRACK—VI

MM-01
Mathematical Model Study on the Spread of Corona Virus Infection causing COVID-19

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Abstract: The outbreak of the COVID-19 pandemic has become an emergent serious concern worldwide and therefore, World Health Organization (WHO) has declared it as Health Emergency in March 2020. The outbreak has already taken thousands of lives in each of the affected countries across the world. There is an urgent need to address the issues related to the very fast spreading character of the SARS-CoV-2 that causes the viral disease. The unusual nature of spreading of this corona virus among the human population and the associated factors can be correlated and explained mathematically. A mathematical model based on the Kermack-McKendrick model on the spread of the corona virus infection causing COVID-19 is proposed here. The susceptible individuals become vulnerable when they are exposed to or get contacted with the infectious individuals. As the vulnerability to the disease increases, the number of infected individuals goes up creating a panic and challenging situation in the society. The threshold value related to the vulnerability towards infection is considered as focal point in this mathematical model. The proposed model is applied and analysed considering COVID-19 situation of Assam to examine its suitability to fit in the real patient population. The model may be extended to other COVID-19 affected area and may be of help to reduce the morbidity and mortality due to the spread of the virus causing the deadly disease.

MM-02
Stability Analysis of a Mathematical Model for Within-host Dynamics of HIV

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Abstract: Acquired Immune Deficiency Syndrome (HIV/AIDS) has become a threat to the humankind which has claimed more than 32 million lives up to November 2019 and the epidemic continues to spread. Researchers have proposed different mathematical models to study within-host dynamics of HIV/AIDS. HIV mainly targets $CD4^+$ T cells, a type of lymphocyte and important part of the immune system. Due to destruction of these $CD4^+$ T cells, host's immune responses to other infections decreases. HIV/AIDS is not curable but it can be controlled by proper treatment procedure. In this paper, we have studied a mathematical model which incorporates logistic growth term for the proliferation of T cells and cure rate for infected T cells. Basic reproduction number (R_0) of the model is calculated and established as a threshold parameter. Also, analytic behaviour of the infection-free equilibrium point is studied locally and globally using Routh-Hurwitz criterion and Lyapunov's second method respectively. The analytic results are verified by numerical simulation. Also, we have explored the effects of different parameters of the model on its dynamics. The overall study implies that we can impose a policy which can reduce the basic reproduction number (R_0) less than or equal to one in order to control HIV infection.

Keywords: HIV/AIDS; Stability analysis; Logistic growth term; Cure rate.

MM-03
Application of Mathematical Models in Pharmaceutical Product Design and Development - A review

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Abstract: This presentation details the application of various mathematical models in designing and developing the pharmaceutical drug product, taking 'tablets' as an example. Application of various mathematical models for Pre-formulation considerations like physicochemical and biological parameters evaluation and in the selection of drug molecules and additive inactive substances, manufacturing process development, quality control evaluation as in-process manufacturing controls and as finished product testing are depicted. Usages of mathematics based in silico methods are visualized in patient centric dose calculation, optimum therapeutic schedule prediction, product performance prediction inside the human body, actual clinical performance design, performance evaluation in human clinical trials and mathematical statistics based representation of clinical trial results. Design of experiments models applied in optimization of product formula, manufacturing process, establishment of design space as control strategy, scale up or technology transfer from lab scale to commercial production scale and the significant benefits due to applied mathematical models are discussed.

MM-04
An Eco-Epidemiological Model With a Predating Scavenger

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Abstract: An epidemiological predator-prey model with a predating scavenger species is proposed and analysed. In our model the intermediate predator community is assumed to have a non infectious disease. The recovery of infected predators into susceptible predator is considered to be density dependent. The stability results for the coexisting equilibrium are determined using Routh–Hurwitz criteria. It is observe that increasing values of the coefficients linked with density-dependent term promote the stability of the coexisting steady state. Period doubling cascade is observed for all the population for varying mortality rate of scavenger species. The associated control problem for the proposed model under linear harvesting has been analyzed for optimal harvesting with help of Pontiyagin's maximum principle.

MM-05
A Mathematical Analysis of Zika Virus Transmission with Optimal Control Strategies

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Abstract: This paper presents a mathematical model for transmission dynamics of Zika virus by considering standard incidence type interaction for the human to human transmission. The model involves the transmission through the bite of infected Aedes mosquitoes and human to human sexual transmission. The equilibria of the proposed model are found and the basic reproduction number R0 is computed. If R0 < 1, the disease-free equilibrium point is locally asymptotically stable and it is also globally asymptotically stable under certain conditions. The analysis shows that the model exhibits the occurrence of backward bifurcation, which suggests that when R0 < 1 is not completely sufficient for eradicating the disease where the stable disease-free equilibrium co-exists with a stable endemic equilibrium. The endemic equilibrium point of the system exists and locally asymptotically stable under some restriction on parameters, whenever R0 > 1. The sensitivity analysis is performed to identify the key parameters that affect the basic reproduction

number, which can be regulated to control the transmission dynamics of the Zika. Further, this model is extended to the optimal control model and to reveals the optimal control strategies we used the Pontryagin's Maximum Principle. It has been noticed that the optimal control gives better result than without the optimal control model. Numerical simulation is presented to support our mathematical findings.

MM-06
A Gene Therapy Model under the Effect of Radiotherapy for Cancer Prevention

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Abstract: Gene therapy is the youngest medical technique to cure Cancer of the physical body. The aim of the cancer gene therapy is to treat or prevent malignant disease by using the therapeutic information encoded in DNA sequences. Also by generating a high concentration of an effector protein gene therapy prevents cancer growth also. Radiotherapy is usually highly effective for tumour eradication. Radiation is conveyed to destroy malignant tumours either externally by X- rays and γ - rays or internally with the use of radioisotopes. It's clinically proven that the combination of gene therapy and radiotherapy may perform well to eradicate cancer instead of other cancer treatment. There are many mathematical models are introduced by many researchers to investigated the efficient drug delivery process to eradicate cancer. During this study, we analysed a cancer gene therapy model, and within the next, analysed this basic model with the effect of a single dose of radiotherapy by using some mathematical tools. Finding equilibrium point and native stability analysis is completed both theoretically and numerically. Numerical simulation of every modelled is shown for better understanding of the treatment strategy to cure cancer. In our investigation, Gene therapy might not eradicate cancer if the patients have a high rate of growth of cancer with lower immunotherapy drugs but it's going to eradicate cancer if the patient tolerates higher treatment immunotherapy drug dose. In our study, we observed that gene therapy combined with radiotherapy may eradicate cancer all right and during a short time of region.

Keywords: Modelling, Local Stability, Cancer Treatment, Gene Therapy, Radiotherapy.

MM-07
Modelling the Dynamics of Cholera Transmission with Vaccination and Sanitation

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Abstract: In this paper, a new deterministic model for the transmission dynamics of Cholera disease with vaccination and sanitation is formulated. Cholera is an infectious disease which transmitted by water and food that has been contaminated by human waste. The existence and stability of different equilibria of the model are studied and analyzed in detail. The basic reproduction number (R_0) of the model is computed. The disease-free equilibria of the model is locally as well as globally asymptotically stable under some restriction on parameters, whenever $R_0 < 1$. The endemic equilibria of the system exist and locally asymptotically stable under certain conditions, whenever $R_0 > 1$. The sensitivity analysis is performed to identify the key parameters that affect the basic reproduction number, which can be regulated to control the transmission dynamics of the Cholera disease. Finally, numerical simulation is performed to illustrate the analytical findings.

MM-08

A Model of Cooperation between Harvesters and the Nature for Better Survival of a Species using Biological Integrity

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Abstract:

Objectives: Our objective of this work is to study and develop harvesting models incorporating cooperation of harvesters for better survival of a species.

Method/Statistical Analysis: Using the idea of Biological Integrity and the rationality of Cooperative Game Theory, the whole study is carried out. Since, the more an environment is altered, less the biological integrity it holds. Game Theory has the capability to address the economic and social problems of pollution, consumption of resources, and sustainable development. Mathematica Software is used to solve the nonlinear problems associated with our study.

Findings: The findings of our study can be stated as follows

1. Two types of harvesting models are formulated incorporating cooperation of harvesters in harvesting a species in single period and multiple periods of harvesting separately for better survival of the species.
2. Rearing a species is very important to harvest more in future is discussed.
3. The notion of penalty is introduced to protect the irrational harvesting or overharvesting for better survival of a species.

Applications/ Improvements: If the super-authorities like state, country apply these type of harvesting models incorporating Biological Integrity as a measure, then it will be safeguard for a species.

Keywords: Biological Integrity, Harvesting, Nonlinear Optimization

MM-09

Predicting demographic and socio-economic factors of morbility: An application of logistic regression model

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Abstract: In this paper an attempt has been made to trace the demographic and socio-economic factors of morbidity and to assess the prevalence of multi-morbidity among the elderly persons in a particular area. To meet these objectives binary multiple logistic regression model has been adopted. In addition basic statistical tools have also been employed to study the morbidity pattern in the study area. The most common morbidities in the study area were High Blood Pressure, Arthritis, Cataract, Diabetes, Loss of teeth, and Alzheimer. No significant differences in occurrence of multi-morbidities had been noticed with respect to sex. Overall prevalence of multi-morbidity was found to be 80%. Logistic regression model showed that sex, residential status, education and cigarette smoking were the most important predictors of multi-morbidity. The analyses have been carried out using statistical software SPSS.

Key-words: Elderly, Morbidity, Logistic regression Model.

MM-10

ARIMA Model in Bayesian Approach: A statistical Investigation based on Road Accident Data in India

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Abstract: The primary goal of analyzing any time series data is to formulate and fit an appropriate mathematical model for the series. Once an appropriate model is found and fitted

to data the analyst can carry on further analysis using the model. ARIMA Model is widely used in forecasting time series data. The parameters of the ARIMA Model are usually estimated using classical approach (either maximum likelihood or least square method). With recent advances in computing technology, Bayesian approaches to parameter estimation are now computationally feasible. In this paper an attempt has been made to estimate the parameters of ARIMA Model under Bayesian approach. To start with Bayesian analysis, it is necessary to specify prior distribution over the parameter space. Different prior distributions can be used in this study according to all currently available information. If prior information on the study parameters is unavailable or does not exist for a device, then initial uncertainty about the parameters can be quantified with a non informative prior distribution. Posterior distributions of the parameters are estimated using Markov Chain Monte Carlo (MCMC) simulation. After estimating the parameters, check the forecasting performance of the model. Also, check the fit of the models by using Cox-Snell residual plot.

Key Words: *MCMC, Prior distribution, Posterior distribution, R Software.*

MM-11
Will Traditional Dress Vanish due to Impact of Western Culture?

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Abstract: "Suria" and "Mekhela-Saador" are considered cultural heritage of Assam. There was a time when people always wore these traditional dresses. Western dress was not in practice until few decades back. Because of this, local textile and handloom industry flourished in the region. They were also contributing to Gandhi's 'Khadi' and 'Swaraj' dream. Even though till the last generation mostly traditional dress was used, there is a sharp decline in the use of traditional dresses in recent times. It is becoming a norm for the present generation to wear traditional dresses like "Suria" and "Mekhela-Saador" only on certain occasions. That time is not far when even this will no longer be the case. Unlike the previous generations, it is becoming a rule amongst the masses to wear western dress, rather than an exception. This not only is a danger to our cultural heritage, but also a threat to our local handloom and textile industry. In this paper, we propose a mathematical model of why and how this is happening. We analyse the dynamics as predicted by our model and observe its correlation in real life. We also see where we are heading to and possible measures to revert the situation- if we wish to!

Keywords: Nonlinear Dynamics, Dynamical Systems, Mathematical Modelling, Traditional dress.

MM-12
Dynamics of a predator-prey patchy model with delay dispersal

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Abstract: Dispersal of a species from one patch to another becomes necessary for survival and growth of a species. Various factors like resource competition, kin-competition avoidance, safe breeding, predation, etc. play key role in migration of species. In this article, we develop a predator-prey model occupying two identical patches. The movement (dispersal) of the prey from one patch to another is density independent in the absence of predators. However, due to the presence of predators, impact of predator-influenced dispersal is also taken into account. Furthermore, the movement of the species is effected by time delay (referred as travel time). The model possesses at most one coexisting equilibrium. At first we prove that the instantaneous dispersal has no effect when the isolated patch is stable. But due to time delay in movement, the stability of the patches can change. Several types of stability behaviors are discussed by selecting the ecological parameters. It is shown that delay dispersal has potential to induce instability change as well as stability switching in patchy model. Thus, our

model of the predator-prey behavior in two different patches might contribute in understanding the ecological behaviors of species as a whole when they migrate from one region to another.

Keywords: Rosenzweig-MacArthur model, Random dispersal, Dispersal delay, Stability, Transversality condition, Delay differential equation.

MM-13

Modelling to Study the Impact on Unemployment through highly Skill Development

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Abstract In this paper, we formulate a nonlinear mathematical model to study the role of highly skill development on unemployment and analyze it analytically as well as numerically. We assume that government promote different levels of skill development programs for unemployed persons. Hence, two different categories of skilled persons, namely the low-skilled, and the highly skilled persons are coming out and highly skilled persons are able to create vacancies. The model is studied using stability theory of nonlinear differential equations. The paper finds that the model has only one non-negative equilibrium which is stable under certain conditions. The analysis of the model reveals that highly skilled persons play crucial roles to control the unemployment by creating new employment opportunities.

MM-14

Fitting Parametric Accelerated Failure Time with Frailty Model in Case of Oesophagus Cancer Patients Data

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Abstract: Frailty is a random component and it is usually designed to account the variability due to some unobserved factors. The random effects, its relationship and some undetected heterogeneity into survival model is analyzed by frailty model. In survival analysis, frailty is the analysis of failure time data where the covariate effect is multiplicative on the baseline hazard function assumed to follow some theoretical distribution. In this paper, an attempt has been made to fit various distributions by applying Accelerated Failure Time with frailty model in case of total 178 oesophagus cancer patients diagnosed in Assam, North- East India. Cox Snell residuals plot is used to present the data graphically. From the analysis, the Weibull AFT model with frailty is found to be the best fitted model in case oesophagus cancer patients diagnosed in Assam, North- East India.

Keywords: survival, accelerated failure time, Cox Snell residual, random effect, heterogeneity.

MM-15

Analysis and prediction for the spreading of covid-19 pandemic in India using Mathematical modeling

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Abstract: In the present time, the biggest problem of the world is the outbreak of novel corona virus. Novel corona virus (COVID-19), this one name has become a part of our daily lives over the past few months. Beyond the boundaries of medical science, corona virus is now the main subject of research in all fields like Applied Mathematics, Economy, Philosophy, Sociology, and Politics up to living room. The epidemic has brought unimaginable changes in our traditional habits and daily routines. Thousands of people in our country are fighting with the rest of the world to survive in various new situations. There are different kinds of corona virus appeared in different times. In this time, Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2) is responsible for the corona virus disease of 2019 (COVID-19). This virus was first identified towards the end of 2019 in the city of Wuhan in the province of Hubei in China. Within very short duration of time and very fast, it has spread throughout a large part of the world. In this study, the main aim is to investigate the spreading rate, death rate, recovery rate due to corona virus infection and to study the future of the corona virus in India by using mathematical modeling based on the previous data. Mathematical models, in this situation, are the important tools in recruiting effective strategies to fight this epidemic. India is at high risk of spreading the disease and is facing many losses in socio-economic aspects. With current infection rates and existing levels of personal alertness, the number of infected people in India will increase at least in the next three months. Proper social awareness, maintain of social distance, large rate of testing and separation may break the chain of the Coronavirus-2.

Keywords: Corona Virus; Covid-19; India; Pandemic; Mathematical modeling

MM-16

On the stability of athreatened stage-structured Prey-predator model in presence of additional food for the Predator

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Abstract: A stage-structured prey-predator mathematical modelis proposed and discussed to study their dynamics in a natural habitat where the adult prey is threatened bypoaching activity and the juvenile prey is killed by the predator population. An additional food parameter is incorporated in the system, since, the juvenile prey is not the only food for the predator. Thus, the predator is assumed to prey on juvenile prey with modified Holling type-II functional response. The stability of each equilibrium point of the system is established and existence of Hopf-bifurcation for the coexistence equilibrium point of the system is investigated. Furthermore, some dynamic behaviors of the systems are clarified by numerical simulations.

Keywords: Stability; Additional food; Poaching; limit cycle; Hopf Bifurcation.