# ALU MATH MINDS

## Mathematical modelling

Mathematical modeling is a method of representing real-world phenomena, systems, or processes using mathematical structures, equations, and concepts. It involves creating a mathematical description that captures the essential features and behavior of a system or phenomenon of interest. The goal is to simplify, analyze, and understand complex real-world situations by translating them into mathematical language. Mathematical models can take various forms, including equations, graphs, or other mathematical expressions.



Mathematical Modeling Process
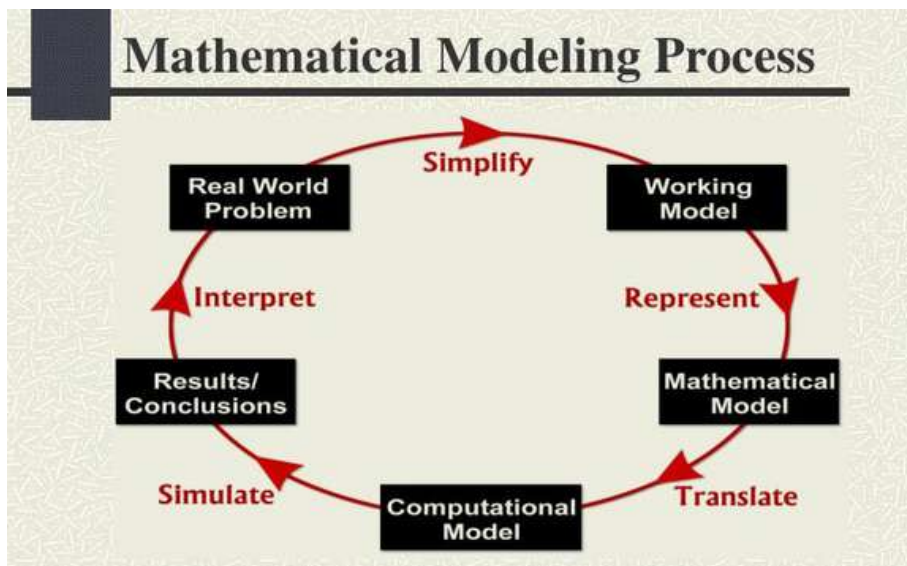
### Messege from the chair

This is a message from Dr. N. Anbazhagan, the chair of the department, to the alumni and friends of the department. He welcomes them to the May 2020 newsletter and shares some news and updates about the faculty, students, and events of the department. He also invites them to support the department and to stay in touch.

# MODEL MASTERY

- **Understanding Complex Systems:** Many real-world systems are too complex to be fully understood through intuition alone. Mathematical models provide a systematic and structured way to understand the underlying dynamics of these systems.

- **Prediction and Forecasting:** Mathematical models allow researchers and practitioners to make predictions about future behavior or outcomes of a system. This is valuable in fields such as weather forecasting, finance, and epidemiology, where predicting future trends is essential.

- **Optimization:** In various fields, there is a need to optimize certain parameters or find the best solution to a problem. Mathematical models help in formulating and solving optimization problems, leading to more efficient and effective solutions.

- **Scientific Research:** In scientific research, mathematical models are used to test hypotheses, simulate experiments, and analyze data. They help researchers gain insights into complex phenomena, guide experimentation, and make predictions that can be tested against empirical observations.

- **Engineering Design:** Engineers use mathematical modeling to design and optimize systems, structures, and processes. Whether it's designing a bridge, an electrical circuit, or a chemical process, mathematical models play a crucial role in ensuring the feasibility and efficiency of the design.

- **Decision Making:** Mathematical models assist decision-makers by providing a quantitative basis for decision-making. This is evident in fields such as finance, economics, and operations research, where models help in evaluating different scenarios and making informed choices.

- **Resource Allocation:** In economics, ecology, and other resource-dependent fields, mathematical models help in understanding how resources are allocated and utilized. This is important for sustainable development and efficient resource management.

- **Simulation and Virtual Testing:** Mathematical models enable the simulation of real-world scenarios without the need for physical experimentation. This is particularly valuable in fields like physics, chemistry, and engineering, where experiments may be costly, dangerous, or not feasible.

- **Communication:** Mathematical models provide a common language for scientists, researchers, and practitioners to communicate and share ideas. They facilitate the exchange of knowledge and allow for a standardized approach to problem-solving.



## QUANTUM QUOTES

- "Predicting tomorrow's unknowns: Mathematical modeling as the crystal ball of science."

- "Numbers whisper, equations speak, and mathematical models tell the story of our world."

- "In the world of uncertainty, mathematical modeling is the compass that guides us through the complexity of reality."

- "Cracking the code of reality: Mathematical modeling as the master key."

# Know the mathematician
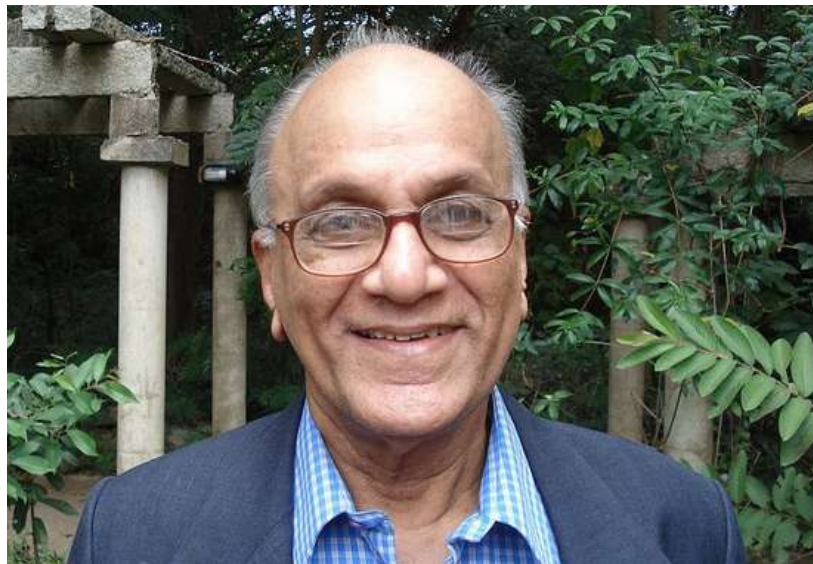
## C.S. SESHADRI

Conjeevaram Srirangachari Seshadri (29 February 1932) is a renowned Indian mathematician. He is the founder and director-emeritus of the Chennai Mathematical Institute and is known for his work in algebraic geometry. The Seshadri constant is named after him. He was also known for his collaboration with mathematician M. S. Narasimhan, for their proof of the Narasimhan–Seshadri theorem which proved the necessary conditions for stable vector bundles on a Riemann surface.

### Contributions

Seshadri's main work is in algebraic geometry. His work with M S Narasimhan on unitary vector bundles and the Narasimhan–Seshadri theorem has influenced the field. His work on Geometric Invariant Theory and on Schubert varieties, in particular his introduction of standard monomial theory, is widely recognized.
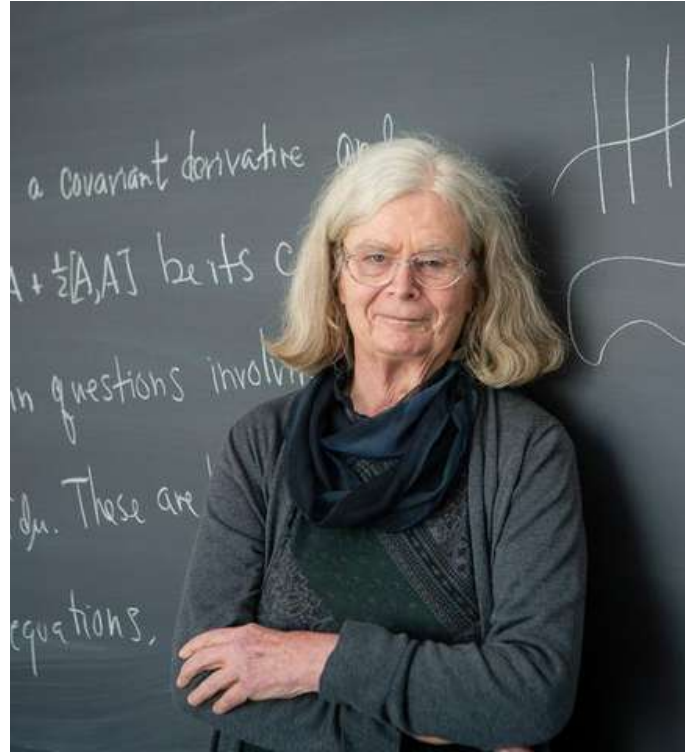
### Awards

- Padma bhusan
- Shanti Swarup Bhatnagar Award
- Srinivasa Ramanujan Medal
- Fellow of the Royal Society
- Fellow of the American Mathematical Society

### Positions

Seshadri worked in the School of Mathematics at the Tata Institute of Fundamental Research in Bombay from 1953 to 1984 starting as a Research Scholar and rising to a senior professor. From 1984 to 1989, he worked at the Institute of Mathematical Sciences, Chennai. From 1989 to 2010, he worked as the founding director of the Chennai Mathematical Institute. After stepping down he continued to be the institute's Director-Emeritus till his death in 2020. He also served on the Mathematical Sciences jury for the Infosys Prize in 2010 and 2011.

# ABEL PRIZE 2019



| Biography | |
|---|---|
| Born | Karen KeskullaAugust 24, 1942 (age 81)Cleveland, Ohio, U.S. |
| Education | University of Michigan, Ann Arbor (BA)New York UniversityBrandeis University (MA, PhD) |
| Known for | Calculus of variationsGeometric analysisMinimal surfacesYang–Mills theory |
| Spouses | Olke C. Uhlenbeck(m. 1965–1976), Robert F. Williams (m. – present) |
| Awards | MacArthur FellowshipNoether Lecturer (1988)National Medal of Science (2000)Leroy P. Steele Prize (2007)Abel Prize (2019)Leroy P. Steele Prize (2020) |
| Scientific career | |
| Field | Mathematics |
| Institutions | Institute for Advanced StudyUniversity of Texas, AustinUniversity of ChicagoUniversity of Illinois, ChicagoUniversity of Illinois, Urbana-Champaign |
| Thesis | The calculus of variations and global analysis (1968) |
| Doctoral advisor | Richard Palais |



## Karen Keskulla Uhlenbeck University of Texas, USA

She has been awarded prestigious Abel prize
"for her pioneering achievements in geometric partial differential equations, gauge theory and integrable systems,
and for the fundamental impact of her work on analysis, geometry and mathematical physics."

The Abel Prize is a scientific award given annually to one or more outstanding mathematicians. The prize is named after the Norwegian mathematician Niels Henrik Abel (1802–1829) and is modeled after the Nobel Prizes.

# ICTP Ramanujan Prize-2019

## Hoàng Hiệp Phạm
## ICTP Ramanujan Prize-2019

- Pham Hoang Hiep is a Vietnamese Mathematician known for his work in complex analysis. He is a professor at the Vietnam Academy of Science and Technology and director of the International Centre for Mathematical Research and Training. He was awarded the 2015 Prof. Ta Quang Buu prize (young prize) and the 2019 ICTP Ramanujan Prize.

## ICTP-Ramanujan Prize

for "outstanding contributions to the field of complex analysis, and in particular to pluripotential theory".

# CHERN MEDAL

- Masaki Kashiwara, Kashiwara Masaki, born January 30, 1947 in Yūki, Ibaraki) is a Japanese mathematician. He was a student of Mikio Sato at the University of Tokyo. Kashiwara made leading contributions towards algebraic analysis, microlocal analysis, D-module theory, Hodge theory, sheaf theory and representation theory.
- Masaki Kashiwara, Kashiwara Masaki, born January 30, 1947 in Yūki, Ibaraki) is a Japanese mathematician. He was a student of Mikio Sato at the University of Tokyo. Kashiwara made leading contributions towards algebraic analysis, microlocal analysis, D-module theory, Hodge theory, sheaf theory and representation theory.

## CHERN MEDAL-2018

"For his outstanding and foundational contributions to algebraic analysis and representation theory sustained over a period of almost 50 years.

# SASTRA Ramanujan Prize

# INFOSYS PRIZE

The SASTRA Ramanujan Prize, founded by Shanmugha Arts, Science, Technology & Research Academy (SASTRA) located near Kumbakonam, India, Srinivasa Ramanujan's hometown, is awarded every year to a young mathematician judged to have done outstanding work in Ramanujan's fields of interest. The age limit for the prize has been set at 32 (the age at which Ramanujan died), and the current award is $10,000.

- Adam Harper is a mathematician specialising in number theory, particularly in analytic, combinatorial and probabilistic number theory. He is currently a professor at the University of Warwick, England. Harper was awarded the SASTRA Ramanujan Prize in 2019 "for several outstanding contributions to analytic and probabilistic number theory.

- "Harper's research, both individually and in collaboration, covers the theory of the Riemann zeta function, random multiplicative functions, S-unit equations, smooth numbers, the large sieve, and the recent highly innovative "pretentious" approach to number theory. In establishing these results, he has shown mastery over probabilistic methods which he has used with remarkable effect in analytic number theory."

- The Infosys Prize is an annual award given to scientists, researchers, engineers and social scientists of Indian origin (not necessarily born in India) by the Infosys Science Foundation and ranks among the highest monetary awards in India to recognize research. The prize for each category includes a gold medallion, a citation certificate, and prize money of US$100,000 (or its equivalent in Indian Rupees). The prize purse is tax free in the hands of winners in India.The winners are selected by the jury of their respective categories, headed by the jury chairs.

- Sunita Sarawagi is an Indian computer scientist known for her research in databases, data mining, and machine learning, including the use of natural language processing to extract structured data from text. She is Institute Chair Professor of Computer Science and Engineering at IIT Bombay.

# PONGAL CELEBRATION-2020



Final year PG students celebrated Tamilar Thirunaal "Pongal 2020". The program was inaugurated by Dr. N. Anbazhagan, Head of the Department of Mathematics, and other faculty members. The preparation, arrangements, and decorations are done by the immense contribution of the students towards the program. The whole function was felicitated in a traditional manner. The students wore traditional dhotis and sarees and the event began with the boiling of rice with jaggery. Followed by, the games and cultural programs were conducted for students.
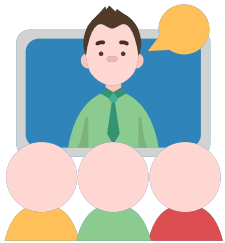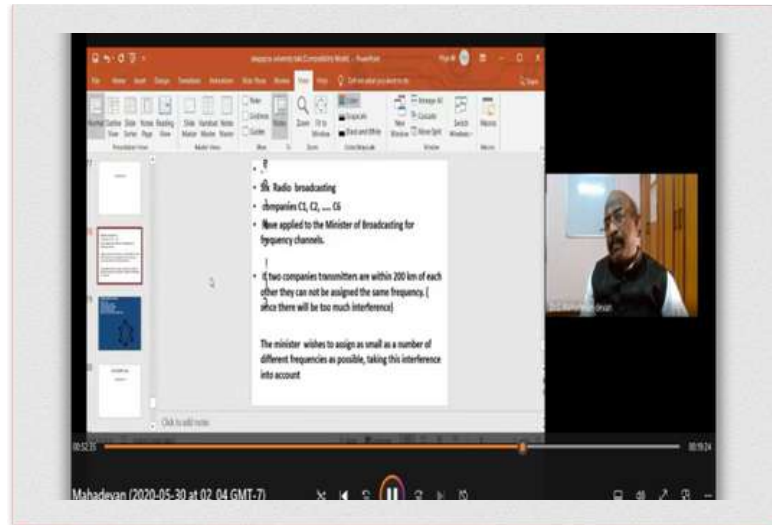
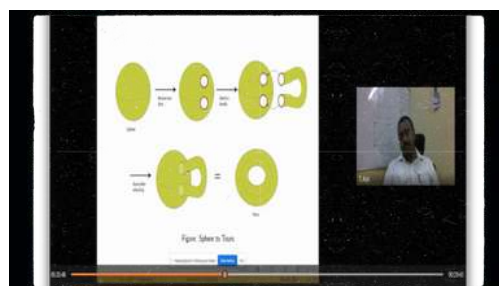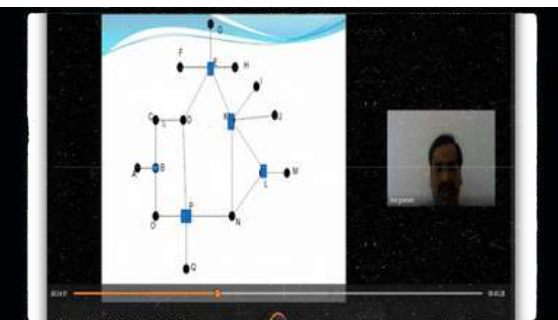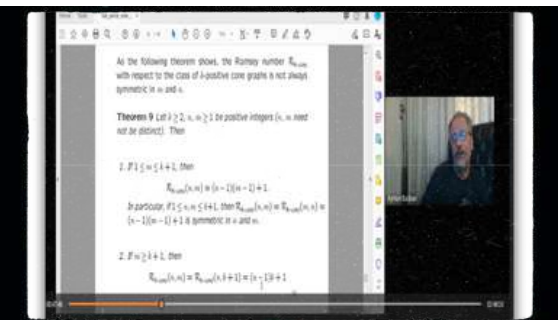# INTERNATIONAL WEBINAR ON RECENT ADVANCES IN GRAPH THEORY



Study the structure of DNA

DNA is a long chain of nucleotides with specific sequences and patterns called base pairs. The structure of DNA can be divided into two parts: A and T, as well as G and C (the four letters). Each letter has its own function in making up different amino acids that form proteins. Research shows that graph theory can be used to model biological processes like gene regulation, transcriptional control, and expression levels among others.

Two days International Webinar on "Recent Advances in Graph Theory" was organized by Department of Mathematics, Alagappa University, Karaikudi on 29th and 30th May 2020. Prof. N. Anbazhagan, Head of the Department of Mathematics welcomed the gathering. Prof. N. Rajendran, the Honorable Vice-chancellor of Alagappa University presided the Webinar. The eminent speakers Prof. Ayman Badawi, American University of Sharjah, Sharjah., Dr. C. Sivagnanam Sur College of Applied Sciences, Sultanate of Oman, Dr. T. Asir Madurai Kamaraj University, Maduraiand Dr. G. Mahadevan Gandhigram Rural Institute, Gandhigram gave special lectures on various topics.

**Prof. Chee Peng Lim**
**Deakin University, Australia.**

**Prof. Valentina Emilia Balas**
**Aurel Vlaicu University of Arad, Romania.**

**Prof. Ovidiu Bagdasar**
**University of Derby, United Kingdom.**

**Prof. Fathalla A. Rihan**
**United Arab Emirates University, UAE.**

**Prof. Poom Kumam**
**King Mongkut's University of Technology Thonburi, Thailand.**

- The 2nd International Conference on Mathematical Modelling and Computational Methods in Science and Engineering (ICMMCMSE-2020) was held at Alagappa University under the auspices of the School of Mathematics and the Department of Mathematics from 22nd to 24th January, 2020.

- A souvenir containing abstracts of research papers was released by the Vice-Chancellor and the copies were received by the distinguished guests. In all 315 papers were presented in 13 technical sessions conducted on all the three days of the conference. Of these 40 papers were presented by scholars from abroad.

- Prof. Martin Bohner, Missouri University of Science and Technology, USA, Prof. Dumitru Baleanu, Cankaya University, Turkey, Prof. Valentina Emilia Balas, Aurel Vlaicu University of Arad, Romania, Prof. Poom Kumam, King Mongkut's University of Technology, Thailand, Prof. Chee-Peng Lim, Deakin University, Australia, Prof. Fathalla A. Rihan, United Arab Emirates University, UAE and Prof. Ovidiu Bagdasar, University of Derby, England delivered invited lectures.

- Distinguished Indian Mathematicians Prof. Natesan Srinivasan, IIT, Guwahati, Prof. Paramasivan Arumugam, IIT, Roorkee, Prof. Muslim Malik, IIT, Mandi, Prof. E. Natrajan, Indian Institute of Space Science and Technology, Trivanduram and Dr. Izhar Uddin, Jamia Millia Islamia, Delhi were the other star speakers at the conference.

- Earlier, Dr. N. Anbazhagan, Professor and Head, Department of Mathematics, Alagappa University, in his welcome address, referred to the objectives of the conference. The main aim is to provide a forum for researchers and experts from Mathematics background in science and engineering to exchange recent trends in this field and to expose the scholars here to innovative and interdisciplinary research, he added. Dr. R. Raja, Convener of the conference, proposed a vote of thanks.

# NATIONAL WORKSHOP ON DYNAMICAL SYSTEM WITH MATLAB AND ITS COMPUTATIONS



- Prof.N. Rajendran, Vice Chancellor, Alagappa University, who presided over the function. In his presidential address, he highlighted the importance of Mathematics and the main motive of conduct the National workshop. He also gave assurance that Alagappa University support software development. He advised the students to gain the software knowledge.

- Dr. V. Govindaraj, National Institute of Technology, Puducherry, offered felicitations. Three hundred participants attended the workshop. Dr. N. Anbazhagan, Professor and Head, welcomed the participants. Dr. V. Govindaraj delivered the lecture about the importance of MATLAB software in Mathematics On the second and third day, Dr. M. Sambath, Periyar University, Salem, delivered the lecture at the technical session. Dr. V. Parthiban, VIT, Chennai, conducted the practical session for participating students. During the Valedictory function, certificates were distributed to all the participants. Dr. B. Sundaravadivoo proposed a vote of thanks.



**National Workshop on Dynamical System with MATLAB and its Computations (NWDMC-2020), organized by the School of Mathematics, Alagappa University, under the financial support of UGC-SAP (DRS-I), was held on 09.01.2020.**

# NATIONAL CONFERENCE ON CHALLENGES IN MATHEMATICAL MODELLING



A two-day National Conference on "Challenges in Mathematical Modeling" on February 20–21, 2020, was organized by the School of Mathematics, Alagappa University, at the University Convocation seminar hall, which has been sponsored by UGC-SAP (DRS-I).

On Day 1, Prof. N. Rajendran, Vice-Chancellor, Alagappa University, presided over the function, and he delivered his presidential address about "Why is Mathematics considered a Queen of Science?" and also shared how Mathematics plays an important role in all other fields such as engineering, marine, quantum physics, and many more. After that, the session was handed over to the speakers, Dr. Pankaj Srivastava, MNNIT, Allahabad, and Dr. B. Krishna Kumar, Anna University, Chennai. They shared and discussed their thoughts and ideas with the youngsters.
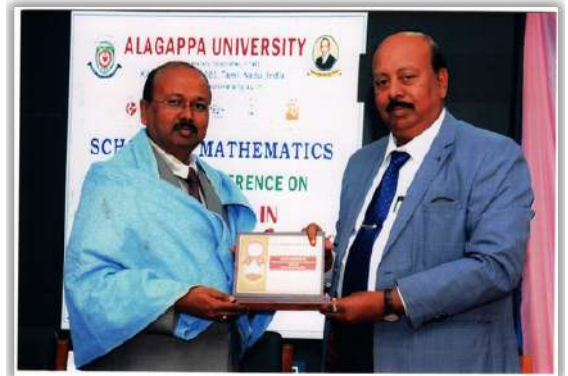




On Day 2, Dr. M. Lellise Thivagar, Madurai Kamaraj University, Madurai, and Dr. R. Natarajan, former professor at Alagappa University, delivered their invited lectures. The paper presentation session took place after the invited lectures.In this Conference, about 30 research papers were presented, and 200 students from various institutions including our University were participated.

# MATH FACTS

▶ The word "hundred" comes from the old Norse term, "hundrath", which actually means 120 and not 100.

▶ In a room of 23 people there's a 50% chance that two people have the same birthday.

▶ Conversely, "one" is the only number that is spelt with letters arranged in descending order.

# NATIONAL MATHEMATICS DAY-2019



In honour of the great Indian Mathematician Shri Srinivasa Ramanujan's 132nd Birthday(22.12.2019), celebrated as National Mathematics Day on 17th December 2019, which was jointly organized by Department of Mathematics, and Ramanujan Centre for Higher Mathematics at Alagappa University. Hony. Col. Prof. N. Rajendran, Vice-Chancellor, while presiding over the ceremony, emphasized that the purpose of the day is to encourage the students an optimistic perspective on the intrinsic worth and crucial role of learning Mathematics, which is recognized as the mother of all scientific disciplines. He talked about Ramanujan's early fascination with numbers and mathematical prowess.

> Mathematics is not about numbers, equations, computations or algorithms; It is about understanding.
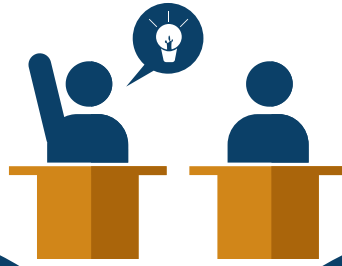>
> – S. Ramanujan



**2520** is the smallest number that can exactly be divided by all numbers from 1 to 10, and it is discovered by an Indian Mathematician **Srinivasa Ramanujan**

# STATE LEVEL QUIZ CONTEST - 2020

A State-Level Quiz Contest - 2020 for PG students was organized by the Department of Mathematics, Alagappa University, Karaikudi on 03.03.2020. Prof. N. Anbazhagan, Head of the Department of Mathematics, welcomed the participants.

Prof. N. Rajendran, the Vice Chancellor of Alagappa University, who presided over the event, emphasized that participating in quiz competitions could enhance the critical thinking, logical reasoning abilities, and self-confidence of the participants when confronting National-level competitive exams. Also, he pointed out that quiz programs offer the added benefits of improved concentration and the identification of knowledge gaps.

Prof. T. Tamizh Chelvam, formerly the Head of the Department of Mathematics at Manonmanian Sundarnar University, Trinelveli, delivered a special address and served as a Quiz Master. He said that the participation of the Mathematics quiz program, it will equip participants to confidently tackle a wide range of competitive exams.

Over 20 teams from different educational institutions were participated in the quiz. The top three prizes were won by Bharathidasan University, Trichy, T.D.M.N.S College in T. Kallikulam, and Manonmaniam Sundarnar University, Tirunelveli. Professor T. Tamizh Chelvam handed out the prizes to the winners, and Dr. J. Vimala, Assistant Professor, Department of Mathematics, Alagappa University, delivered the vote of thanks.

# EMERGING ALERTS

## COVID-19
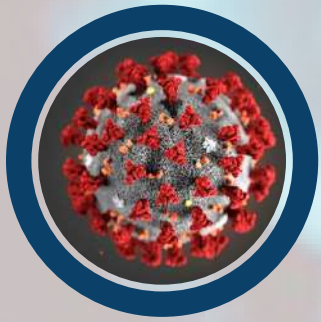
### SITUATION In NUMBERS

India
26 917 Confirmed
826 Deaths
32 States/UTs

South-East Asia
41 073 Confirmed
1658 Deaths

Globally
2719 897 Confirmed
187 705 Deaths

WHO Classification India - Clusters of   case

## Prevention Measures

- Social distancing was enforced, maintaining a minimum of six feet between individuals.

- Lockdowns and stay-at-home orders were implemented to restrict movement and gatherings.

- Face masks became widely recommended, with some places mandating their use in public spaces.

- Hygiene practices, especially frequent handwashing, were emphasized to prevent transmission.

- Testing and contact tracing efforts were increased to identify and isolate COVID-19 cases.

- Quarantine and isolation measures were advised for individuals showing symptoms or testing positive.

- Travel restrictions, including border closures and quarantine for travelers, were imposed.

- Public spaces, non-essential businesses, and schools were often temporarily closed.

- Health authorities continuously updated guidelines based on evolving information.

# MATH'S REAL-WORLD WONDERS

**DID YOU KNOW?**

## BOTS

PDEs, ODEs equation like this helps to provide shapes and interior and exterior designs of machine

## SOFTWARE

The use of differential equations to understand computer hardware belongs to applied physics or electrical engineering

## Networking

To understand a outcome of a edges creation model like preferential attachment which says that nodes with probability proportional to their existing degrees.

## Movie Graphics

- Movie graphics put the math and art of digital images in motion. They rely on high level mathematical concepts to simulate familiar visual, auditory, and movement patterns. Math touched everything from lighting to colour to shape. It's also used in the storage and transmission of the graphics.

- Movie graphics often incorporate vector spaces in three-dimensions. Check out chapter on vectors for a deeper look at vector arithmetic.

## MRI and Tomography

MRI scanners can create three-dimensional images of the human body by taking countless two-dimensional "snapshots" from different directions. The process of recovering the original 3-dimensional model using these snapshots is called *tomography* – and it wouldn't work without advanced mathematics such as *Radon Transforms*. Mathematics is quite literally saving lifes.

## Bonds between atoms and molecule

Atoms are held together by chemical bonds to form compounds and molecules. Covalent, polar covalent, and ionic connections are all types of chemical bonding. The second-order differential equations are used to express them. This equation comes in handy to distinguish between the adhesion of atoms and molecules.
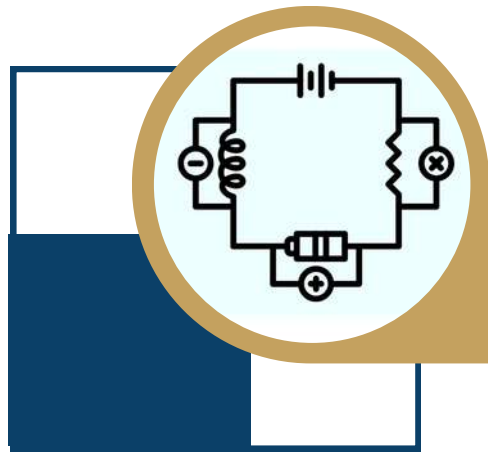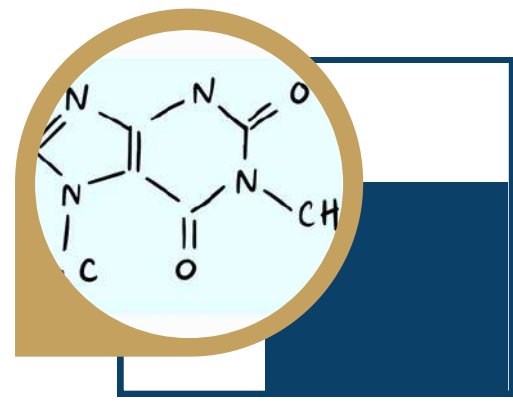
## Systems of the electric circuit

The differential equation of the same type determines a circuit consisting of an inductance L or capacitor C and resistor R with current and voltage variables. The differential equation is regarded as conventional when its second order, reflects the derivatives involved and is equal to the number of energy-storing components used.

## Population growth

Recording the population growth rate is necessary since populations are growing worldwide daily. We thus take into account the most straightforward differential equations model available to control a particular species' population dynamics.

## Weather prediction

- The weather is an incredibly complex system with billions of molecules interacting. This makes predicting the weather a surprisingly difficult tasks even using the extensive network of weather stations satellites and the world's largest supercomputers.

- Fluids like the atmosphere follow a set of rules called the *Navier Stokes equations*. Unfortunately we don't know a direct solution for these equations – one of the greatest unsolved problems in mathematics and one of the $1 million *Millennium Prize Problems*.

# SATELLITE NAVIGATION

- To determine any location on Earth satellite navigation systems like GPS use signals from satellites which provide extremely accurate times. By finding their delay a computer can calculate how far away the satellites are. If you know the distance from at least three different satellites and the position of these satellites you can find the unique and exact position of the receiver on Earth.

- For accuracy, you have to take account of numerous physical issues: according to Special Relativity time moves faster for the satellite because it is moving so fast and slower because it is further from the Earth's gravitational field. Both effects are tiny and undetectable in everyday life. But without taking these effects into account GPS receivers would accumulate an error of 10 km per day!

- A *metric space* is the mathematical generalisation of measuring distances. Because of general relativity GPS receivers have to use the *Kerr metric* rather than the usual Euclidean metric.

# BUILDING BRIDGES

Suspension bridges are elegant bridges that span distances between 300 and 2300 meters. Their flexibility and low deadweight are great for engineering. These same qualities are also liabilities. Suspension bridges are actually quite flexible to prevent buckling. This flexibility causes also means these bridges are susceptible to *resonance*. Resonance is a phonomenon modelled using second-order differential equations.

# CORAL REEF GROWTH

Coral reefs are incredibly diverse underwater ecosystems. Many reefs struggle to stay healthy with sea temperature rise and other human and enviromental factors. Models using *differential equations* help scientists understand reefs decline.

# COSMOLOGY

Cosmology is the study of the origin and evolution of our universe. Mathematical equations can model this process from the Big Bang until today and can even predict what will happen to the universe in the future. Our universe is expanding at a rapid speed and the rate of expansion follows the *Friedmann Equations* which can be deduced from Einstein's field equations of gravitation. The fate of the universe depends on the amount of matter (= energy) in the universe and astronomical observations suggest the existence of *dark matter* and *dark energy*. Mathematicians also use supercomputers to model the universe very shortly after the Big Bang.

## READING CDS AND DVDS

- Data on CDs and DVDs is stored as a series of tiny "hills" and "valleys" engraved in the surface of the discs more than 10 times smaller than the width of a human hair.

- Scratches and dust on the surface of the disk can destroy the hills and valleys together with the information they encode. This should mean that a DVD or CD should play incorectly or not at all.

- Mathematics can help solve this problem: data stored on discs is encoded using Reed-Solomon codes. These are designed in a way that even if parts of the data is missing or incorrect computers can use the remaining data to find and correct errors: to fill the gaps.

- This only works if a certain proportion of the data is correct, so you can't play a CD which is completely scratched.

- Cross-interleaved Reed-Solomon codes used for CDs and DVDs are based on polynomials over finite fields.
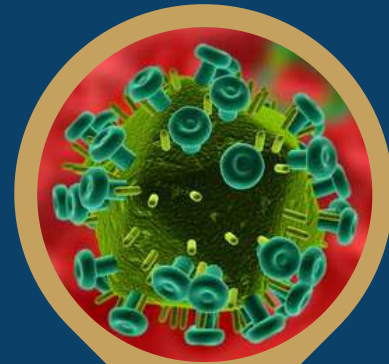


## EPIDEMICS ANALYSIS

When a new epidemic starts one can fear that it will not stop since there are always new cases. This is not what mathematics says. The important quantity is the reproductive ratio, R0, which corresponds to the mean number of individuals infected by each infectious person. If R0 < 1, then the epidemic dies, while it spreads if R0 > 1. The knowledge of R0 guides the strategy to control the epidemic. In particular, in case of limited resources (for instance not enough vaccines for everyone), the goal is to use these resources to decrease R0 below 1.

## AUTOMOTIVE DESIGN

Many engineers involved in designing cars use mathematics. For example, the way air moves around the car at different speeds directly impacts how much fuel the car uses. The design team must take aerodynamics into account. They likely uses *Computer-Aided Design* (CAD) software to assess the aerodynamics of their designs, as well as Computer-Aided Engineering (CAE) including *Finite Element Analysis* and *Computational Fluid Dynamics*.

# CSIR-NET
# Question bytes

**Q.1** For a quadraticform in 3 variables over R, let r be the rank and s be the signature. The number of possible pairs (r,s) is

(1) 13
(2) 9
(3) 10
(4) 16

**Q.2** Let $X \subset R$ be an infinite countable bounded subset of R. Which of the following statements is true ?

(1) X cannot be compact
(2) X contains an interiorpoint
(3) X may be closed
(4) closure of X is countable set

**Q.3** Which of the followingsets is countable ?

(1)The set of all functions from Q to Q
(2) The set of all functions from Q to 0,1
(3)The set of all functionsfrom Q to 0,1 whichvanish outside a finite
(4) The set of all subsets of N

**Q.4** Let $(X_n)_{n \geq 1}$ be a sequence of non-negative real numbers. Then,which of the following is true ?

(1) $n$ lim inf $x_n = 0 \Rightarrow \lim x_2 = 0$
(2) $n$ limsup $x_n = 0 \Rightarrow \lim x_2 = 0$
(3) liminf $x_n = 0 \Rightarrow (x_n)_{n \geq 1}$ is bounded
(4) liminf $x_2 > 4 \Rightarrow$ limsup $x_n > 4$

**Q.5** A permutation $\sigma$ of $[n]$ = 1,2,...n is called irreducible, if the restric- tion $\sigma|[k]$ is not a permutation of $[k]$ for any $1 \leq k < n$. Let $a_n$ be the number of irreducible permutations of $[n]$. Then $a_1 = 1$, $a_2 = 1$ and $a_3 = 3$. The value of $a_4$ is

(1) 12
(2) 13
(3) 14
(4) 15

**Q.6** Let X be an infinite set. Consider the topology $\tau$ on X whose non- empty open sets are complements of finite sets. Then which of the following statements is true ?

(1) X is disconnected
(2) X is compact
(3) No sequence in X converges in X
(4) Every sequence in x convergesto a unique point in x

**Q.7.** Let S5 be the symmetric group on five symbols. Then which of the following statements is false ?

(1) S5 contains a cyclic subgroup of order 6
(2) S5 contains a non-Abelian subgroup of order 8
(3) S5 does not containa subgroup isomorphic to Z/2Z × Z/2Z
(4) S5 does not containa subgroup of order 7

**Q.8.** Consider the polynomial $f(z) = z_2 + az + p_{11}$, where $a \epsilon Z$ 0 and p 13 is a prime. Suppose that $a_2$ $4p_{11}$. which of the following state- ments is true ?

(1) f has a zero on the imaginaryaxis
(2) f has a zero for whichthe real and imaginary parts are equal
(3) f has distinctroot
(4) f has exactly one real root

**Q.9.** Let G be a group of order $p_n$ , p a prime number and n › 1. Then which of the followingis true ?

(1) Centre of G has at least two elements
(2) G is always an Abeliangroup
(3) G has exactly two normal subgroups (i.e., G is a simple group)
(4) If H is any other group of order $p_n$, then G is isomorphic to H

**Q.10** Let x =ξbe a solutionof $x_4 - 3x_2 + x - 10 = 0$. The rate of n, n convergence for the iterative method $x_{n+1} = 10 - x_4 + 3x_2$ is equal to

(1) 1
(2) 2
(3) 3
(4) 4

# BRAINY TIME

| 5 |   | 9 | 4 |   |   |   |   |   |
|---|---|---|---|---|---|---|---|---|
|   |   | 3 |   |   |   | 6 | 9 |   |
|   | 1 |   |   |   |   |   |   | 5 |
|   | 5 |   | 1 | 8 |   |   |   |   |
| 3 |   |   |   | 5 |   |   |   | 7 |
|   |   |   |   | 9 | 6 |   | 5 |   |
| 9 |   |   |   |   |   |   | 7 |   |
|   | 3 | 8 |   |   |   | 5 |   |   |
|   |   |   |   |   | 7 | 1 |   | 3 |

If you shuffle a deck of cards properly, it's more than likely that the exact order of the cards you get has never been seen before in the whole history of the universe.
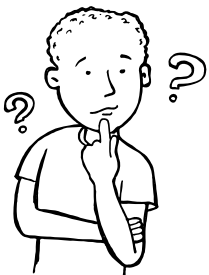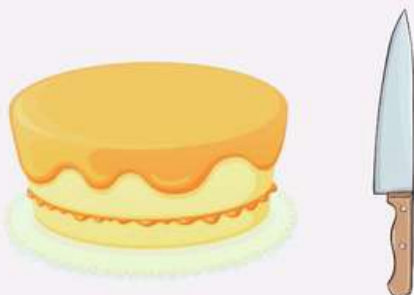
## NUMBER NOOKS

- 26 is the only natural number sandwiched between a perfect square number (25) and a perfect cube number (27).

- The number of possible combinations of a Rubik's Cube is greater than the number of atoms in the universe.

- Every odd number has an 'e'.

- "Forty" is the only number that is spelt with letters arranged in alphabetical order.

# FUN WITH FIGURES

There are 7 people at your birthday party. How can you divide a round cake for 8 people (including you) making only 3 cuts?

3rd cut gives 8 pieces

## Departmental updates

| | |
|---|---|
| Number of research publications | 58 |
| Number of projects undertaken | 1 |
| Department scholarships awarded | 6 |