UGC-HRDC, DR. HARISINGH GOUR VISHWAVIDYALAYA, SAGAR, MP

Detailed Report on

Two Weeks Refresher Course on "Computational Mathematics"

(RC5-20)

(4-18 March 2021)

Day 1 (04-03-2021, Thursday)

The Refresher Course opened with a formal Inaugural Session at 10.00 AM. The distinguished personalities in the virtual dais were **Prof. Diwakar Shukla, Dean SMPS,** Dr. R.T. Bedre Sir, Director HRDC, Dr. Kanhaiya Tripathi, Assistant Director and Coordinator Dr. K.S. Mathur Sir, Assistant Professor, Department of Mathematics and Statistic, Dr. Harisingh Gour Vishwavidyalaya, Sagar, M.P. This session starts with an inauguration of chief guest Hon'ble Vice-Chancellor of UGC-HRDC-Dr Harisingh Gour Vishwavidyalaya, Sagar, Madya Pradesh. In this session participants identified the importance and need of refresher course in "COMPUTATIONAL MATHEMATICS". Dr. Kunwer Singh Mathur Course Coordinator gave the outline of the course and the works that participants would submit during the class. Participants are from different states and some are from disciplines other than Mathematics. Each and every participant introduce themselves and mention the area of research and topic of interest.

After the inaugural session, the second session was handled by Dr. Priti Bagde about the profile of Sir Dr. Harisingh Gour and the university. She used a tree diagram to explain the family members of Sir Dr. Harisingh Gour. He completed his education in prestigious institutions like Cambridge University, Trinity College etc. He was a social reformer, politician, writer and a follower of Buddhism. After that she gave a brief introduction about the facilities, structure, courses offered by institutions like that. One of the main things she specified is the greenery of the university. She explained everything with pictures for better understanding.

The third session in the afternoon was handled by Dr Sandeep Banerjee, IIT Roorkee about the mathematical modelling in applied sciences. He explained how to model a problem mathematically and started with a simple example Prey-Predator model. Then he moves to other models like Lazy Student model, Rumer model, Murder Mystery model, Arm Race model, Stage Structure model like that. He explained everything very clearly and neatly with simple examples in our surroundings so that we can enjoy the class.

The fourth session on Finite Element Method and Applications was handled by V. P. Saxena. FEM is a numerical technique used for the solution of complex problems in diverse fields. It involves using polynomial curves to approximate the actual solutions to differential equations. The number of data points required to determine the polynomial depends on the degree of the polynomial. The solution process consists of Establishing Governing Equations and Boundary Conditions, Dividing Solution Domain into Elements, Determining Element Equations, Assembling Element Equations, Solving the Global Equations and verifying the solutions. The session also included a discussion on the necessity of FEM, Types of FEM, Extensions and pre requisites of FEM, leading software used in it, etc. Then a short introduction to variational methods and Variational (Ritz) FEM was given. Then a discussion on various examples of the application of FEM were discussed, such as One-Dimensional drug Distribution in Human Dermal Region, Thermoregulation in Human Body, Applications in air pollution, etc.

Day 2 (05-03-2021, Friday)

On the second day (05-03-2021), the first session was handled by Dr. Ajay Kumar, ABV- IIITM Gwalior, about simulations. He starts the topic very simply with an example and then moves to classification of simulation like continuous-discrete, stochastic-deterministic. He explained the whole topic in detail with nice and simple examples and wrote the algorithms in an impressive manner. He gave two examples in discrete and continuous stochastic processes each. His presentation was really nice and easy to follow.

The second session was also handled by Dr. Ajay Kumar on the topic" INTRODUCTION TO FUZZY SETS AND FUZZY LOGIC". Like the first session, the second session was also very neatly and carefully handled. He starts with a

simple example to introduce the concept of fuzzy sets and represent the same using set theory notations. He gave a clear idea about the difference between classical sets and fuzzy sets. Then he talked about fuzzy logic, its importance, uses and its limitations also. He concluded the session by providing an example to distinguish the fuzzy approach and non-fuzzy approach in 'The Basic Tipping Problem'.

Third session was handled by Dr. Anupam Priyadarsi, BHU, Varanasi on "INTRODUCTION TO MATLAB BASICS". Initially he introduced the user interface of MATLAB consisting of command window, editor window etc. Then he introduces some commands to load variables in the math file and clear workspace vars, screen, figure. Throughout the session we acquainted with basic syntax and structures which includes mathematical functions, operations, aligning arrays and matrices. In addition, further endeavor is to plot the graph of a function and embedding additional plots to a figure. He concludes this session by mentioning the importance and merits of MATLAB.

The last session was also handled by Dr. Anupam Priyadarsi about" INTRODUCTION TO MATHEMATICAL BIOLOGY". He starts the topic with a diagram connecting Ecological Interaction, Mutualism, Predation and competition in the ecosystem. Then he introduced the mathematical tools and biological patterns to open a way to mathematical modelling. He specified that mathematical modelling needs teamwork and explained the mathematical modeling process very simply with the help of a diagram. He explained the modelling with examples like climate modelling, roadmaps of the human brain etc. He listed the areas of application of math in the biosciences. Finally, he came up with a general and a specific problem regarding axonal transport and explained it in simple words.

Day 3 (06-03-2021, Saturday)

On 06-03-2021, the first session was handled by Dr. Ajay Kumar, ABV-IIITM Gwalior on "INTRODUCTION TO MACHINE LEARNING". He starts with a diagram that gives an outline of Machine Learning. He classified it into three parts supervised learning, unsupervised learning and reinforced learning and explained each one with an example. He gave a small description of Linear regression and then discussed Logistic regression with its classification like binary Logistic regression, Multinomial Logistic regression and ordinal Logistic

regression. He explained how to build regression step by step. Then introduce Python Programming and gave ideas about libraries, how to start it, how to call a function, how to plot functions etc. Like in the previous lectures he really impressed us with his classes.

Like the previous day, the second session was also handled by Dr Ajay Kumar about "INTRODUCTION TO MARKOV PROCESS AND CHAIN". It was an informative class who does not have a statistical background. Initially he starts with the Markov chain and moves to queueing theory. In the starting of the session, he defines the Markov process and classifies it into two deterministic processes and stochastic processes with some examples. He simply defines stochastic processes as a family of random variables and gives an idea about chains, DTMC and CTMC, how to form a transition matrix, finding the transition probability etc. His way of giving the examples was really nice and very easy to understand.

The first and second session after the lunch break was handled by Dr. Prashant Shrivastava about "STABILITY ANALYSIS FOR SYSTEM OF NONLINEAR ODES". Initially he gave an outline about the topic and proceeded to the further details. He starts with the definition of first order differential equation, its initial value problem, number of solutions of an ODE. Then he moves to a topic of another level system of differential equations, critical points and its stability, physical interpretation of it. He explained the solution of the system of nonlinear ODE with 3 different examples and gives a geometrical interpretation of it. The last topic of the presentation was about Lyapunov stability and Bifurcation. He completed the entire topic in the limited time and presented it very neatly.

Day 4 (08-03-2021, Monday)

On 08-03-2021, the first session was handled by Prof. Malay Banerjee, IIT Kanpur about "SPATIO-TEMPORAL PATTERN FORMATION". At first, he gave the outline of the topic by presenting a lot of pictorial slides like Ribbon forest, Savanna forest, Wetland vegetation etc. Then he presents spatio-temporal models like the Prey-Predator model, Effect of local death and birth using partial differential equations. He gave an outline about the whole topic in limited time effectively.

Second session was handled by Dr. Sushil Keshaw, Associate Professor, Department of Pharmaceutical sciences about “MODELLING OF INFECTIOUS DISEASE”. He starts with a quoting of Albert Einstein and Stephen Hawking and moves to the drug discovery and development phase. Then he explained about the various steps to invent an appropriate medicine to the infectious disease and explain Pharmacore mapping. It was really an interesting section because of his nice presentation and way of communication.

Afternoon session was handled by Dr. Govind Prasad Sahu about the topic “USER DEFINED FUNCTIONS AND LOOPS IN MATLAB”. He starts with basic topics so that we can follow him easily. He introduced basic structures like keywords, different loops like FOR, WHILE etc, and also how to define functions in MATLAB. He deliberately introduced errors in the example and then pointed out those errors so that the participants get an idea about syntax.

Last session was also handled by Dr. Govind Prasad Sahu about the topic “INFECTIOUS DISEASE MODELLING IN MATLAB”. The discussion starts with an explanation of various stages in modelling. Then he introduced different parameters that are used in such a model such as R0. Then the SIR model was discussed in detail. He also talked about the origin of mathematical epidemiology. Overall, the session was very informative and he is really a good teacher.

Day 5 (09-03-2021, Tuesday)

On 09-03-2021, the first session was managed by Prof. Malay Banerjee, IIT Kanpur about the topic “STATIONARY AND NON-STATIONARY PATTERNS - NUMERICAL DECTECTIONS”. Initially he gave the outline of the topic and explained the main topics Numerical simulation for temporal model and numerical simulation for spatio temporal model very neatly by graphical as well as analytical method. He gave the points step by step to find the stable and unstable point. It was really a nice talk.

The second session was handled by Dr. Triloki Nath, DHSG VV Sagar about the topic “COMPUTATIONAL LINEAR ALGEBRA”. He started with the importance of the system of linear equations and gave the geometric interpretation of it. Then discussed different methods to solve the system of equations like Gauss Jacobi iteration method, Gauss Seidel Iteration method,

Gauss Jordan method etc. The topic selection was really awesome and the presentation was time bound.

Third session was handled by Dr. Dheerendra Mishra, MANIT Bhopal about the topic “MATHEMATICS OF PUBLIC KEY CRYPTOGRAPHY ". He starts by explaining how to transfer a message from messenger to receiver by one way function with Trapdoor. Then he moves to some results in number theory. Then he moves to digital signature and its classification and talks about the signature scheme and its principle. It was really an interesting topic

The last session was handled by Dr. R K Pandey about the topic “INTRODUCTION TO NUMERICAL METHOD AND COMPUTATION ANALYSIS”. He discussed numerical methods like Newton's Raphson method, Simpson method and interpolation methods like Newton's forward difference and backward difference formula, Lagrange's method with its applications. He is really a good teacher. He makes concepts very simple to make everyone understand the topic.

Day 6 (10-03-2021, Wednesday)

On 10-03-2021, the first session was handled by Prof. K.R. Pardasani, MANIT, Bhopal about “COMPUTATIONAL MODELS OF CALCIUM DIFFUSION IN NEURONS”. He starts with the definition of Neuroinformatic and its 3 pillars (Neuroscience data and databases, computational neuroscience, software tools), then moves to structure, parts, functions, chemical reaction behind the working of neurons. Then he moved to resting potential, action potential and explained polarisation neatly. He gave an idea about how the movement of calcium and sodium in the blood cells and introduced a finite element and Fourier series to study two-dimensional calcium diffusion in neuron cells. It was really a refreshing experience for us to go through biology after a long time.

The second session was handled by Prof. Joydip Dhar, ABV-IIITM Gwalior about the topic “NEW PRODUCT MARKETING INNOVATION DIFFUSION MODELLING”. It is a topic of importance every time. He explained everything very simply and motivated the participant by his presentation topic and way of presenting. He explained innovation of the diffusion model for the survival of a product in the competitive market. And factors affecting them. He gave a good

mathematical modelling and its formulation. His class was really impressive and encouraging to each research scholar.

The third session was handled by Dr. V.N Mishra, IGNTU Amarkantak, MP, about the topic "CERTAIN GENERAL FAMILY OF POSITIVE LINEAR OPERATORS". The topic selection was good. He introduced sequence, convergence of sequence, series, convergence of series, various methods to check convergences of series, various types of summabilities, pointwise convergence of the series, properties of Lipschitz class etc in the limited time. If he presents the PPT from the beginning of the class then it would be very easy to follow more than that his network connection is also bad.

The last session was handled by Dr. Lakshmi Narayan Mishra, VIT University Vellore, TN about the topic "FRACTIONAL DIFFERENTIAL AND INTEGRAL EQUATIONS". He starts with Integral equations like Fredholm and Volterra equations and defined L^p space. Then move to various types of operators like superposition operator, Urysohn integral operator, multiplication operator etc and discuss various fixed-point theorems. He mentioned the algorithm of a nonlinear problem along with boundary condition. He winds up the portions as soon as possible.

Day 7 (12-03-2021, Friday)

On 12-03-2021, the first session was handled by Dr. Prashant Kumar Shrivastava, IIT Patna about the topic "Stochastic Models and Computations". He starts with Deterministic system and stochastic system. He gave a single population model as an example of a stochastic system. He divided this problem into two 1) single population models (with birth only) 2) single population models (with birth and death process). He gave a brief introduction on stochastic differential equations also. His class was really interesting and gave motivation to faculties who were attending this course.

The second session was handled by Dr. Prashant Shukla, DHSG VV Sagar about the topic "Polarization based optical imaging techniques: As a diagnostic tool". He introduced three types of polarisation 1) Linear polarisation 2) Circular polarisation 3) Elliptical polarisation and gave graphical representation of it. Later he discussed Dichroism and Birefringence. In the next section he gave the matrix representation of polarisation, explained Jones vector, Jones matrix for

some standard components, Stokes parameters, representation of Polarisation states by Poincare sphere. It was a good lecture and we all enjoyed it.

The third session was handled by Dr. Brajesh Kumar Jha, PDEU Gujrat about the topic "Introduction of Computational Neuroscience". He started with the Central nervous system and Peripheral nervous system and explained the main unit of it" Neurons" in detail. Explained sodium potassium pump neurotransmitters, Calcium regulatory mechanism, Calcium buffering, Calcium flux etc. Finally, he mathematically models the flow of calcium with the help of differential equations with initial and boundary conditions. His slide presentation was really good.

The last presentation was handled by Dr. Girish Kumar DHSG VV Sagar about the topic "Complexity Calculation of Algorithms". He starts with definitions of algorithms and types of algorithms like Recursive Algorithm, Divide and conquer Algorithm, Dynamic Programming Algorithm, Greedy Algorithm, Brute Algorithm, Backtracking Algorithm. Then he gave an introduction to Big-Oh(O) notation. His class was impressive and useful to all of us.

Day 8 (13-03-2021, Saturday)

Morning Session was '*Micro Teaching Presentation'* chaired by Dr. Anupam Priyadarsi, Assistant Professor, Department of Mathematics, BHU Varanasi. A total of six participants presented their teaching skills through presentations relating to various topics of Mathematics. Professor Priyadarsi supported and motivated the participants.

The chairman of Second Session was again Dr. Anupam Priyadarsi, Assistant Professor, Department of Mathematics, BHU Varanasi. In this session 05 participants presented their topics and the experienced Professor supported the participants along with some important suggestions.

In the Post-Lunch Session, the five participants presented their micro teaching topics and the session was chaired by Dr. R.K. Pandey, Department of Mathematics and Statistics, Dr. Harisingh Gour Vishwavidyalaya, Sagar. He supported the presenters very positively and asked many questions pertaining to it.

In the Last Session, was chaired by Dr. M.K. Yadav, Department of Mathematics and Statistics, Dr. Harisingh Gour Vishwavidyalaya, Sagar Five participants presented the micro teaching in diverse fields and the chairman made some important suggestions to modify the skills.

Day 9 (15-03-2021, Monday)

Morning Session was again '*Micro Teaching Presentation'* which was chaired by Dr. Govind Prasad Sahu, Centre for basic sciences, Pt. Ravishankar Shukla University Raipur, C.G. A total of four participants presented their teaching skills through presentations relating to various topics of Mathematics. Dr. Sahu supported and motivated the participants.

The Second Session was '*Seminar Presentation'* chaired by Dr. V.N. Mishra, Associate Professor and HOD, Department of Mathematics, IGNTU Amarkantak, M.P. In this session 05 participants presented their research paper through seminar and the Dr. Mishra supported all the participants along with some important suggestions.

In the Post-Lunch Session, again five participants participated in seminar presentations and this session was chaired by Dr. Ashok Kumar Sah, B.R.A. Bihar University Muzaffarpur. He supported the presenters very positively and asked many questions pertaining to it.

The Last Session, was chaired by Dr. Brajesh Kumar Jha, PDEU, Gujrat and in this session five participants presented the seminar in diverse fields and the chairman made some important suggestions to modify the skills.

Day 10 (16-03-2021, Tuesday)

Morning Session was again '*Seminar Presentation'* which was chaired by Dr. Triloki Nath, Department of Mathematics and Statistics, Dr. Harisingh Gour Vishwavidyalaya, Sagar. A total of four participants presented their seminar through presentations relating to various topics of Mathematics. Dr. Nath supported all the participants along with some important suggestions.

The Second Session was chaired by Dr. Dheerendra Mishra, MANIT Bhopal. In this session again 04 participants presented their research paper through seminar and the Dr. Mishra supported and motivated the participants.

In the Post-Lunch Session, only three participants participated in seminar presentations and this session was chaired by Dr. Shudhansu Kumar, Department of Mathematics and Statistics, Dr. Harisingh Gour Vishwavidyalaya, Sagar. He supported the presenters very positively and asked many questions pertaining to it.

The Last Session, was chaired by Dr. Kavita Shrivastava, Department of Mathematics and Statistics, Dr. Harisingh Gour Vishwavidyalaya, Sagar. In this session, the participants have started to present their research project proposal. A total of four participants presented their proposal in diverse fields of mathematics and the resource person made remarkable comments on them.

Day 11 (17-03-2021, Wednesday)

The Morning Session of '*Project Proposal Presentation*' was chaired by Prof. Diwakar Shukla, Dean SMPS, Dr. Harisingh Gour Vishwavidyalaya, Sagar. There was a total of 04 participants presented their project proposal. Participants presented topics from various areas of their domain. Chairman supported and motivated all the participants.

Session Two was chaired by Dr. Muslim Malik, Associate Professor, IIT Mandi. With is huge knowledge in the research field, he supported the presenters very positively and asked many questions. The participants presented topics from various areas of their disciplines. In this session 4 participants presented their proposal brilliantly. The mood of the fellow participants was also supportive.

The Post-Lunch Session was started with a brain-teasing '*Multiple Choice Test*' as part of the evaluation process. All the participants attended the MCQ after revising the topics covered in the refresher course. The test was conducted via Google Quiz. After submitting the response sheet, participants could able to saw their scores.

Last Session chaired by Dr. Gajendra Kumar Vishwakarma, IIT Dhanbad. In this session 04 participants presented their project proposal with good time management. The chair asked questions and gave some important modifications to their proposed project.

Day 12 (18-03-2021, Thursday)

Session One started with an invited speaker Dr. Bramhadeep Alune, Assistant Director, Department of Higher Education, Govt. of MP, who delivered an interested talk on Leadership programme. The session was very informative and interactive. Participants has asked several questions and resource person replied the answers very gently.

Dr. Lakshmi Narayan Mishra, VIT University Vellore, started Session Two of '*Project Proposal Presentation'*. A total of four participants presented their project proposal. The resource person, listened to their presentations and made detailed comments/suggestions.

In Session Three, Dr. Punam Gupta, Department of Mathematics and Statistics, Dr. Harisingh Gour University chaired '*Project Proposal Presentation'*. The remaining participants presented their proposal very well and the chair supported them as well.

Last Session was devoted to 'Feedback and Valedictory' from among the participants of the refresher course, and the felicitator was one of the participants Mrs. Serin Elezabeth Joy. All participants expressed high satisfaction on topics covered, practical done, quality of resource persons and the way in which the programme was orchestrated by Team HRDC, Dr. Harisingh Gour Vishwavidyalaya, Sagar, MP. In the valedictory function the Director R.T. Bedre Bedre sir and Assistant Director Dr. Kanhaiya Tripathi congratulated coordinators Dr. K.S. Mathur for their hard work and dedication for the giant success of the programme. The chief guest of this session was Prof. Renu Jain, Hon'ble Vice Chancellor, DAVV Indore, who expressed our thoughts and enlighten the knowledge on Computational Mathematics. Valedictory function terminated with vote of thanks by Director R.T. Bedre and the participants virtually departed from Sagar with the feeling of attending one of the very effective knowledge gaining courses in their life.