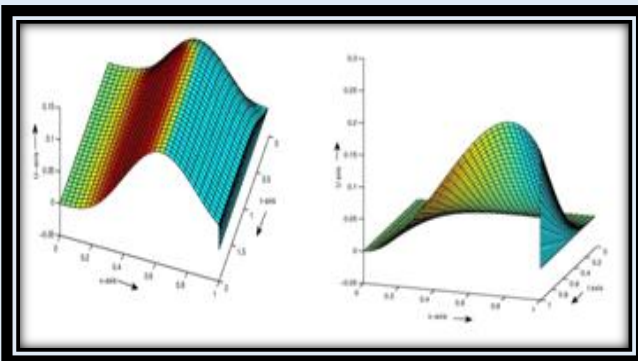


A short-term course  
on  
**Theory and Computation of Singularly  
Perturbed Differential Equations**



**December 04-08, 2017**

Under  
**Global Initiative for Academic Networks  
Ministry of Human Resource Development  
Government of India**



**Organized by**

**Department of Mathematical Sciences  
Indian Institute of Technology (BHU)  
Varanasi-221005, Uttar Pradesh  
India**

**An Overview of the Course:**

Singularly perturbed problems in ordinary and partial differential equations arise as mathematical models in various physical phenomena. For example, mathematical models of liquid crystal, the equations governing flow in porous media, the Navier-Stokes equations of fluid flow at high Reynolds number, and the drift-diffusion equations of semiconductor device, all are singularly perturbed. In general, the solutions to singularly perturbed problems exhibit boundary and/or interior layers (narrow regions where the solution changes drastically) due to the presence of small perturbation parameter. Although the layer regions are small, their influence on the overall solution is very significant. Due to layer behavior of the solution, classical numerical approaches are not adequate for solving singularly perturbed problems, as they require prohibitively large numbers of mesh points to produce satisfactory approximations. This leads to the development of so-called parameter-robust or uniformly convergent numerical methods for singularly perturbed problems.

The principal goal of this course is to present a variety of non-classical approaches based on finite differences and finite elements for the construction of robust numerical methods for singularly perturbed problems. Further, stability, consistency and convergence of numerical methods for singularly perturbed problems will be discussed. Along with the theory, the development of robust implementations of numerical methods using widespread conventional languages of scientific programming will be presented, leading to a deeper understanding of practical aspects of these methods, and providing a framework for developing an intuitive understanding of them. To conclude, some open problems will be outlined, and challenges involved in solving them will be discussed.

**Main Topics:**

- ✦ Introduction to singularly perturbed problems, Numerical methods and uniform convergence, Asymptotic analysis.
- ✦ Finite difference methods and their analysis for singularly perturbed problems, Coupled systems of singularly perturbed problems.
- ✦ Singularly perturbed parabolic problems in 1D, High order numerical methods for singularly perturbed problems.
- ✦ Finite element methods and their analysis, Finite elements in two and three dimensions.
- ✦ Singularly perturbed parabolic problems in 2D, Moving mesh methods for singularly perturbed problems.

**Who can Attend?**

- ✦ M.Sc./B.Tech./M.Tech./Ph.D. students from various institutes, universities and research organizations across the country.
- ✦ Faculty/Researchers/Scientist from academic/technical institutions and R&D Centre across the country.

**Registration Process:**

**Step 1: One-time Registration on GIAN portal** (if already registered, go to step 2 for details regarding institute registration for this course)

**Web link:** <http://www.gian.iitkgp.ac.in/GREGN/index>

Note that registration to the portal is one-time affair and will be valid for lifetime of GIAN. Once registered in the portal, an applicant will be able to apply for any number of GIAN courses as and when necessary.

**Step 2: Institute Registration:** All participants are required to pay the appropriate registration fee as given below.

<b>M.Sc./B.Tech./M.Tech./Ph.D. students</b>	<b>Rs. 1000</b>
<b>Faculty/Scientist/Researchers from academic/technical institutions</b>	<b>Rs. 3000</b>
<b>Participants from industries</b>	<b>Rs. 3500</b>
<b>Participants from abroad</b>	<b>USD 200</b>

Participants are requested to email the scanned copy of duly filled registration form given at the end, along with the receipt of prescribed fee submitted through State Bank Collect, on or before November 24, 2017, with the subject 'TCSPDE GIAN Participant' to [skumar.mat@iitbhu.ac.in](mailto:skumar.mat@iitbhu.ac.in). The procedure for making the fee payment is as follows.

**Payment Instructions:** Access <https://www.onlinesbi.com>. Click on **SB Collect**. Click Checkbox to accept 'Terms & conditions'. Then click on '**Proceed**'. Select state as '**Uttar Pradesh**'. Select type of category as '**Educational Institutions**'. Click on '**Go**'. Select the name of institutions as '**Indian Institute of Technology (B.H.U.), Varanasi**'. Select payment category as '**GIAN-short term course participation fee**'. Fill up the form and pay the fee according to your participation category. Save the receipt for record and get SB collect reference number; you need to fill it on registration form.

## About the City:

The holy city of Varanasi is known as the city of temples and learning. It is a place of great historical and cultural importance. This religious capital of India is situated on the bank of the holy river Ganges and is famous for temples of Lord Shiva, Buddha (at Sarnath) and Sankat Mochan etc. Varanasi is the premiere most place of oriental learning also. Simultaneously it is keeping pace with modern advanced knowledge. The city is reputed for silk fabrics, perfumes, artistic brass and copper wares and a variety of handicrafts. This vibrant city with multiple dimensions of knowledge and liberation has a magnetic attraction for people all over the world.

## How to Reach?

The city of Varanasi is well connected by road, rail and air with all the important places of India. Regular flights are there from Varanasi to Delhi, Mumbai, Chennai, Bangalore, Kolkata, Khajuraho and Lucknow. The Banaras Hindu University campus is only 10 Kms from Varanasi railway station, 20 Kms from Mughal Sarai railway station and 35 Kms from the airport.

## About the Department:

The Department of Mathematical Sciences, IIT (BHU) earlier known as Mathematics / Applied Mathematics has been functioning since 1968. Its importance lies in the fact that it caters to the needs of the undergraduate as well as post-graduate students of the Institute. In addition, the Department runs its own 5-year Dual Degree (B Tech & M Tech) programme in Mathematics & Computing. Computing is the glamour of the Department. It annexes several dimensions in terms of new and growing areas of research and further facilitates simulation of mathematical models constructed for interdisciplinary areas.

## Accommodation:

The participants may be provided with accommodation at the Institute Guest House/ Hostels on nominal payment basis subject to availability. Request for accommodation has to be sent in advance. Otherwise, participants will have to make their own stay arrangement.

## About the Faculty:



Dr. Niall Madden  
School of Mathematics,  
Statistics and Applied  
Mathematics,  
National University of Ireland,  
Galway, Ireland

Dr. Niall Madden is lecturer in School of Mathematics, Statistics, and Applied Mathematics at National University of Ireland, Galway, Ireland. He earned his masters (1996) from University College Cork and Ph.D. (2000) from National University of Ireland, Cork. He is author of more than 33 publications in international journals of repute. His current research interests are in Finite Element and Finite Difference Methods, Preconditioning and Fast Multigrid Solvers, Sparse Grid Methods, ADI Techniques. He has organized several conferences and workshops. He is also member of the editorial board of Numerical Algorithms.



Dr. Sunil Kumar  
Department of mathematical  
Sciences, Indian Institute of  
Technology (BHU), Varanasi  
Uttar Pradesh-221005, India

Dr. Sunil Kumar is Assistant Professor in Department of Mathematical Sciences, IIT (BHU), Varanasi, India. He earned his masters degree from IIT Roorkee and doctorate degree from IIT Delhi. He carried out his postdoctoral research at IISc Bangalore (2012) and University of Coimbra, Portugal (2012-2014). He was then a research scientist at Max Planck Institute for Solar System Research, Germany (2014-2015). He also served as Assistant Professor at NIT Delhi (2015-2016). His research interests are in Numerical Analysis of Partial Differential Equations, Domain Decomposition Methods, Singular Perturbation Problems, and Mathematical Image Processing.



Prof. L. P. Singh  
Department of mathematical  
Sciences, Indian Institute of  
Technology (BHU), Varanasi  
Uttar Pradesh-221005, India

Dr. L. P. Singh is Professor in Department of Mathematical Sciences, IIT (BHU), Varanasi, India. He has done his masters and Ph.D. from BHU, Varanasi. His research interests are in Non-linear waves and Computational Fluid Dynamics.

## Important Dates:

Course duration	December 04-08, 2017
Registration starts on	October 01, 2017
Last date of registration	November 24, 2017

## Address for all Correspondence:

### Course Coordinator

Dr. Sunil Kumar,  
Assistant Professor,  
Department of mathematical Sciences, IIT (BHU)  
Varanasi, Uttar Pradesh-221005, India  
Email: skumar.mat@iitbhu.ac.in  
Mobile No.: +91 7835014019

For more details and regular updates, please visit the following webpage:

<https://skumarmath.wordpress.com>

## Further Information:

- Number of participants for the course will be limited to forty.
- List of participants will be available on the above webpage on November 26, 2017.
- Accommodation will be provided on first come first serve basis.
- Bring your fee receipt, registration form, and selection confirmation to attend the course.
- Participants will be provided registration kit and course material covering the entire course. The registration fee includes all instructional materials, computer use for tutorials and assignments, and free internet facility.
- There will be continuous evaluation of each participant during the course on understanding of the concepts and skills. Based on the performance, winners will be announced and some prizes may be given.
- After successful completion of the course, all participants will get participation certificate.
- Last but not least, do not hesitate to contact the course coordinator if you have any questions or require any information about the course.

Indian Institute of Technology (BHU), Varanasi

Department of Mathematical Sciences

Registration Form

Theory and Computation of Singularly Perturbed Differential Equations

December 04-08, 2017

Under

Global Initiative of Academic Networks (GIAN), MHRD

1. Name .....

2. a) Age ..... b) Sex: M/F .....

3. Designation .....

4. Organization .....

5. Address for correspondence

.....

.....

E-mail..... Phone/Mobile.....

6. Highest Academic Qualification.....

7. Specialization .....

8. Category of Participant

+ Faculty/Research Scholar/Student of IIT (BHU)

+ Faculty/Research Scholar/Student of other institutions

+ Industry Participant

+ Foreign Participant

9. IIT (BHU) Accommodation Required Yes  No

10. Payment Details

+ Amount (Rs.) .....

+ SB Collect Reference Number .....

*Payment mode: Through SB collect (see brochure for details regarding payment procedure)*

Please register me for the course on **Theory and Computation of Singularly Perturbed Differential Equations** to be held at IIT (BHU) Varanasi.

Date.....

Place .....

Signature of the Participant