JAHRUL M. ALAM
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Citizenship

Permanent Resident of Canada, Citizen of the People's Republic of Bangladesh

Languages

English[1](second language with native level fluency) and **Bengali**(first language).

Research interest

- Fluid dynamics of the atmosphere and ocean.
- High performance scientific computing (MPI, CHARM++)
- Wavelet methods for turbulence modelling.
- Adaptive climate modelling.

Education

(i) **PhD in Applied Mathematics** (2003-2006), McMaster University, Hamilton, Canada.
(*Supervisor:* Prof. Nicholas Kevlahan.) **Thesis:** *A space-time adaptive wavelet method for turbulence*

(ii) **MSc in Applied Mathematics** (1998-2000), University of Alberta, Edmonton, Canada.
(*Supervisor*: Prof. John C. Bowman) **Thesis:** *A fully Lagrangian advection scheme for Electro–Osmotic flow*

(iii) **MSc (first class) in Applied Mathematics** (1989-1990), University of Chittagong, Bangladesh.

(iv) **BSc (honour's, first class) in Applied Mathematics** (1985-1989), University of Chittagong, Bangladesh.

[1]In addition to studying/working in Canada for 8 years, I have 4 years University education and 5 years University teaching experience in Bangladesh, where the language of instruction is English for all post-secondary education in Science and Engineering.

Employment

- **Aug 2008-current:** ***Assistant Professor***, Department of Mathematics and Statistics, Memorial University of Newfoundland, Canada.
- **Sep 2007-July 2008:** SHARCNET Post-doctoral fellow, Department of Earth and Environmental Sciences, University of Waterloo, Canada
- **Jan 2007-Aug 2007:** Post-doctoral fellow, Department of Earth and Environmental Sciences, University of Waterloo, Canada
- **Jan 2003-Dec 2006:** Research Assistant, McMaster University, Canada
- **Jan 2003-Dec 2006:** Teaching Assistant, McMaster University, Canada
- **Dec 2000–Dec 2002**: ***Assistant Professor***, Dept. of Mathematics, Shah Jalal University of Science & Technology, Bangladesh.
- **Sep 1998–Nov 2000**: Research Assistant, Dept of Mathematical Sciences, University of Alberta, Edmonton, Canada.

  Sep 1998–Nov 2000: Teaching Assistant, Dept of Mathematical Sciences, University of Alberta, Edmonton, Canada.
- **Apr 1998–Aug 1998**: ***Assistant Professor***, Dept. of Mathematics, Shah Jalal University of Science & Technology, Bangladesh.
- **Apr 1995–May 1998**: ***Lecturer***, Dept. of Mathematics, Shah Jalal University of Science & Technology, Bangladesh.

Awards and scholarships

- 2008-2009: SHARCNET post-doctoral fellowship, University of Waterloo.
- 2007: Visiting research fellowship, Dept of Atmospheric Sciences, National Taiwan University, Taiwan.
- 2007: Post-doctoral fellowship, Dept of Earth and Environmental Sciences, U of Waterloo.
- 2003-2006: SHARCNET graduate fellowship, McMaster University.
- 2003-2006: Graduate research assistantship, McMaster University.
- 2003-2006: Graduate teaching assistantship, McMaster University.
- 2003-2006: Tuition scholarship for international students, McMaster University.
- 2006: Travel grant for Fields institute workshop, University of Ottawa.
- 2005: Travel grant for Fields institute workshop, Carleton University.

- 2005: Travel grant for the Montreal Scientific Computing Days, University of Montreal.
- 2004: Travel grant for PIMS workshop, Banff international research station.
- 2004 : Travel award for higher studies (PhD), Government of the People's Republic of Bangladesh.
- 1998-2000: Graduate research assistantship, University of Alberta.
- 1998-2000: Graduate teaching assistantship, University of Alberta.
- 1998-2000: Tuition scholarship for international students, University of Alberta.

Publications

In refereed journals

1. **Alam, J. M.** and Lin, J. C. *Towards a fully Lagrangian atmospheric modelling system*, Monthly Weather Review (doi: 10.1175/2008MWR2515.1), 136(12), 4653–4667, Dec. (**2008**).
2. Kevlahan, N. K.-R. **Alam. J. M.** and Vasilyev, O. V. *Scaling of space-time modes with Reynolds number in two-dimensional turbulence*, Journal of Fluid Mechanics 570, 217–226 (**2007**).
3. **Alam. J. M.** and Kevlahan, N. K.-R. and Vasilyev, O. V. *Simultaneous space–time adaptive solution of nonlinear parabolic differential equation*, Journal of Computational Physics 214, 829–857 (**2006**).
4. **Alam, J. M.** and Bowman, J. C. *Energy Conserving Simulation of Incompressible Electro-osmotic and Pressure Driven Flow*, Theoretical and Computational Fluid Dynamics 52,133-150(**2002**)
5. Islam, Md. S. and **Alam, J. M.** *Accuracy of the Quadratic Quadrilateral Finite Elements of Straight Sides*, Journal of Bangladesh Mathematical Society (**2002**)

Manuscripts

6. **Alam, J. M.** and Kevlahan, N. K.-R. and Vasilyev, O. V. *A multi-level adaptive wavelet collocation method for nonlinear elliptic problems*, In progress.
7. **Alam, J. M.**, Kevlahan, N. K.-R. and Vasilyev, O. V. *A dynamically adaptive wavelet collocation method for incompressible Electro-Osmotic flows*, In progress.
8. **Alam, J. M.**, Lin, J. C., Kevlahan, N. K.-R. and Vasilyev, O. V. *Towards a multiscale adaptive atmospheric modelling system*, In progress.

In proceedings

9. R. Aggarwala, **J. M. Alam**, Md. S. Islam, M. Lamoureux, M. Paulhus, M. Powojowski, L. Rasekh, *Statistical Design of an Experimental Problem in Harmonics*, Proceedings of the fourth PIMS Industrial and problem solving workshop, (2000)

Thesis

10. **Alam, J. M.** *A space-time adaptive wavelet method for turbulence*, PhD. Thesis, McMaster University, Canada, 2006.

11. **Alam, J. M.** *A Fully Lagrangian Advection Scheme for Electro-Osmotic Flow*, M.Sc. Thesis, University of Alberta, Canada, 2000.

Abstracts/short papers

12. **Alam, J. M.**, Kevlahan, N. K.-R., Vasilyev, O. V. *Multiscale space-time adaptive simulation of 2D incompressible turbulence*. In Bulletin of the American Physical Society: The 58th Annual Meeting of the Division of Fluid Dynamics, 2005, Chicago, Illinois, USA.

13. **Alam, J. M.**, Kevlahan, N. K.-R., Vasilyev, O. V. and Goldstein, D. G. *Simultaneous space-time adaptive wavelet solution of turbulence*. In Bulletin of the American Physical Society: The 57th Annual Meeting of the Division of Fluid Dynamics, 2004, Seattle, Washington, USA.

14. **Alam, J. M.** and Meah, Md. A. *Finite-element Simulation of Two-Dimensional Fluid Flow*, International Conference on Applied Mathematics and Mathematical Physics, 6-9 January, 2003.

15. **Alam, J. M.** *On the spectrum of a scalar field advected by high Reynolds number flow,* International Conference on Applied Mathematics and Mathematical Physics, 6-9 January, 2003.

16. **Alam, J. M.** and Shahjalal, Md. *A splitting based technique for the passive scalar simulation*, International Conference on Applied Mathematics and Mathematical Physics, 6-9 January, 2003.

Invited talks

1. *Multi-scale space-time adaptive wavelet method for atmospheric flows*, **Invited talk** in the Department of Atmospheric Sciences, National Taiwan University, Taipei, 11 December 2007.

2. *Fully-Lagrangian atmospheric modeling*, **Invited talk** in the Department of Atmospheric Sciences, National Taiwan University, Taipei, 29 November 2007.

3. *Multi-scale space-time adaptive wavelet method for turbulence*, **Invited talk** in the Department of Applied Mathematics, University of Waterloo, Canada, 16 November 2007.

4. *Adaptive modelling of turbulence in the Atmosphere* **Invited talk** in the Earth Sciences Seminar Series, University of Waterloo, September 11, 2006.

Meeting presentations

5. *Developing a truly multiscale model for turbulence in environmental flows* **Contributed talk** in SHARCNET's high performance computing days –HPC2007, McMaster University, June 22, 2007.

6. *A multi-level adaptive wavelet collocation method in the space–time domain.* Presented in the Workshop on Numerical, Mathematical and Modeling Analysis related to Fluid Dynamics in Hydrogen Fuel Cells, University of Ottawa, Canada **10-12, May, 2006**

7. *Simultaneous space–time adaptive simulation of turbulence using second–generation wavelets* Presented in Fields-Carleton Workshop on Numerical and Analytic Methods in Fluid Dynamics **5-7 May, 2005**

8. *Multilevel adaptive wavelet space–time simulation of 2D turbulence* Presented in the Montreal Scientific Computing Days, **Feb. 26–27, 2005**.

9. *Simultaneous space-time adaptive wavelet solution of turbulence*. Presented in The 57th Annual Meeting of the Division of Fluid Dynamics, **November 21-23, 2004**, Seattle, Washington, USA.

10. *Simultaneous space-time adaptive wavelet collocation method for intermittent problems in Fluid Dynamics*. Presented in SHARCNET seminar series on HPC, **July 21, 2004**.

11. *Simultaneous space-time solution of partial differential equation*. Presented in PIMS workshop on Adaptive wavelet and multi-scale methods for partial differential equation, **June 3-5, 2004**.

Seminars

12. *Wavelets in scientific computing* Presented in the graduate student seminar, Dept. of Mathematics and Statistics, McMaster University, Canada, Oct. 2004.

13. *Multi-grid technique: the art of scientific computing*, Presented in Seminar series on Nonlinear waves/Fluid Mechanics, Dept of Mathematical Sciences, University of Alberta, Winter 2000.

References

Please contact any of following persons for references

1. Dr. Nicholas Kevlahan – PhD adviser.
   eMail: kevlahan@math.mcmaster.ca
   Associate Professor
   Dept of Mathematics and Statistics
   McMaster University, Canada.

2. Dr. John Lin – Postdoctoral adviser.
   eMail: jcl@uwaterloo.ca
   Assistant Professor
   Dept of Earth and Environmental Sciences
   University of Waterloo, Canada

3. Dr. Bartek Protas
   eMail: bprotas@mcmaster.ca
   Assistant Professor
   Dept of Mathematics and Statistics
   McMaster University, Canada.

4. Dr. Dmitry Pelinovsky
   eMail: dmpeli@math.mcmaster.ca
   Associate Professor
   Dept of Mathematics and Statistics
   McMaster University, Canada.

Programming and numerical methods

- **Languages**: I use Fortran 90 and C/C^{++} extensively to implement high performance adaptive algorithms.

- **Packages and libraries**: R, Matlab, MPI, OpenMP, CHARM^{++}, fftw, LAPACK. I have extensive experience in programming with R, Matlab, and MPI. I have working knowledge of OpenMP and CHARM^{++}. fftw and LAPACK are my favorite libraries. I enjoy LaTeX for text processing.

- **Numerical methods**: I use various numerical techniques such as finite difference, spectral, finite element, and finite volume methods to solve scientific and engineering problems. More specifically, I work on adaptive wavelet collocation method in the finite difference framework, and use pseudo-spectral method for the numerical simulation of isotropic turbulence.

  In addition, I have extensive experience with iterative solvers, such as multi-level or multi-grid techniques, full approximation scheme, Jacobi, Gauss-Seidel, Newton-Rapson, GMRES, BiCGSTAB etc.

Research statement

Overview

Improving our knowledge of turbulence implies a better understanding of fluid flows that are important in environmental, aeronautical, or industrial applications. For example, accurate modelling of the turbulent atmosphere is critical for such varied purposes as weather forecasting, projecting climate change, and mitigating air pollution.

My current scientific interest concerns Fluid Dynamics of the atmosphere and ocean with a specific focus on turbulence – the most outstanding and unsolved problem of classical physics. Turbulence is a multi-scale phenomenon – characterized by a wide range of length and time scales – but the significant proportion of the motion is highly intermittent in space and time (*e.g.,* for spatial intermittency, see Fig. 1). Despite random, chaotic, and irregular nature, the space-time intermittency of coherent structures is among fundamental characteristics of turbulent flows. However, a unique definition of coherent structures or intermittency remain elusive. A better understanding of the intermittency of coherent structures in the atmosphere or ocean is directly related to delineating important aspects of geophysical turbulence.

The objective of this research is to address challenging issues in atmospheric dynamics, transport and chemistry of trace gases, and climate change. Some of my fundamental scientific contributions have been published in prestigious Journals. A brief description of my ongoing research topics are summarised below.

Adaptive modelling of coherent structures in the atmosphere

Our current knowledge of atmospheric flows is an accumulated empirical or statistical information, and adhoc approximation of the average motion. In the atmosphere, small scale phenomena such as cloud or moisture effect is an important aspect of long-range weather forecasting or climate modelling, but modern computing resources are limited to capture such physics from first principles. Since convective plumes in an unstable surface layer transport heat and moisture differently, a complete treatment of the atmospheric boundary layer combined with the treatment of convection is very complex. To study such complex scenario of the atmosphere such that the best numerical approximation is obtained with the least computational effort, a truly multi-scale adaptive atmospheric modelling system is essential. Such a model should refine or coarsen the computational mesh dynamically to follow localized features of a flow, and should obtain a balance between the computational effort of adaptivity and the improvement of accuracy. I have proposed an adaptive atmospheric modelling system, which stems from the intermittent feature of a flow – the inhomogeneous distribution of energy among various scales, the self organization of a random initial condition, and the formation of regions of intense vorticity. The proposed model resolves these intermittently active scales of motion, which contains most of the kinetic energy, and discards all weaker scales. The model has been verified using a two-dimensional coastal motion of a dry atmosphere. Further verification and extension of the model to consider moisture effect and to develop a stochastic perameterization to capture discarded weaker scales is currently underway.

Fully-Lagrangian parcel advection schemes for industrial, environmental, or geoscience applications

Many computer models of industrial, environmental, or geoscience applications concern advection dominated flows. Such models solve either a purely advection problem or a problem where other features are weaker than advection according to a suitable measure. Since the numerical treatment of advection on a conventional Eulerian mesh is plagued with instabilities and unrealistic negative constituent values, continuous efforts have been inspired for finding more elegant, state-of-the-art advection schemes on body fitted Eulerian meshes.

Mathematical models of storing greenhouse gases geologically, electro-kinetic phenomenon in bio-medical engineering, oil/gas reservoir simulation in geoscience are advection dominated problems, where the design of efficient computational algorithms is challenging. I have proposed a fully-Lagrangian advection scheme for accurate simulation of advection. The method has been verified for a two-dimensional flow, where an invading fluid is injected into a domain confined both above and below containing a different resident fluid (*e.g.* fig. 2). Further verification of the method to explain the injection of a greenhouse gas into an aquifer containing a different resident fluid, such as brine is currently underway.

This fully-Lagrangian approach has been extend also to model large-scale atmospheric motion. Comparison of the proposed scheme with equivalent semi-Lagrangian and flux-form Eulerian schemes show that the performance of the fully-Lagrangian model improves both accuracy and CPU time by a significant factor.

Scaling of space-time modes with Reynolds number for 2D and 3D turbulent flows

Turbulence is difficult to approximate mathematically, and to calculate numerically, because it is active over a large and continuous range of length scales (e.g. from less than a millimeter to hundreds of kilometers in the atmosphere). The range of active scales increases with Reynolds number (like $Re^{9/4}$ for three-dimensional turbulence and Re for two-dimensional turbulence) which means flows are increasingly difficult to calculate at the large Reynolds numbers of practical interest. However, it has been conjectured that a turbulent flow can be computed using a finite number of degrees of freedom. But it is not known how sharp this finiteness of turbulence is, in particular, a scaling of the intermittent space-time degrees of freedom with respect to increasing turbulence intensity has not yet been explained with any theory of turbulence.

In my PhD thesis, a scaling of the number of space-time intermittent modes with the Reynolds number for 2D homogeneous isotropic decaying turbulence was estimated numerically. This study further reported that temporal intermittency is much stronger than the spatial intermittency for 2D decaying turbulence.

Currently, I am involved in extending these results to 3D models of turbulence. I am also investigating for a scaling of the number of intermittent space-time modes in the case of forced homogeneous isotropic turbulence.

Energy-conserving Computational Fluid Dynamics (CFD) techniques in complex geometry

In aerodynamics, off-shore drilling, or wind engineering of buildings, one needs simulate moderate to high Reynolds number incompressible flows around arbitrary solid structures. Modelling the body force that is exerted by the immersed solid structure is challenging though a number of approaches have been proposed. Accurate computation of incompressible velocity field on a collocated grid uses generally additional computational effort *via* a velocity or pressure correction scheme. If the mesh is adapted to the intense vorticity filaments near the solid structure, implementation of a staggered grid system is not straight forward.

In this project, I like to investigate the development of an unconditionally stable scheme on collocated Eulerian grid such that energy of the flow is conserved in the inviscid limit by maintaining a divergence free velocity field.

Simultaneous space-time adaptive collocation method

In this project, an $n+t$-dimensional initial value problem is considered as an $n+1$-dimensional boundary value problem in the simultaneous space-time domain, where the time variable is considered as if another spatial variable. A solution of this boundary value problem is a space-time “event” of the underlying physics. Using a space-time wavelet decomposition, region of space-time intermittency is identified.

The method has been verified by solving a number of nonlinear parabolic partial differential equations in $1+t$- and $2+t$-dimensional space-time domain. Extension of this method to $3+t$-dimensional space-time domain requires the development of advanced 4-dimensional data structure. Further, efficient load-balancing parallel algorithm must be developed to improve the performance of solving large computationally intense problems. These works are currently underway.

Summary

Turbulence is ubiquitous, are linked to many issues in environmental or industrial flows, and they form the core picture of numerous scientific and engineering inquiries. Regional and, occasionally, global simulation is required to understand the effects of a wide range of pollutants emitted by multiple sources on different spatial and temporal scales. To deal with this very complex situation it is necessary to use an integrated modelling and analysis framework. The proposed work builds necessary ingredients for these purposes.

Currently, I collaborate actively with John Lin (University of Waterloo) on atmospheric modelling, Nicholas Kevlahan (McMaster University) on turbulent flows in complex geometry, and Oleg Vasilyev (University of Colorado, Boulder) on adaptive wavelet collocation method.

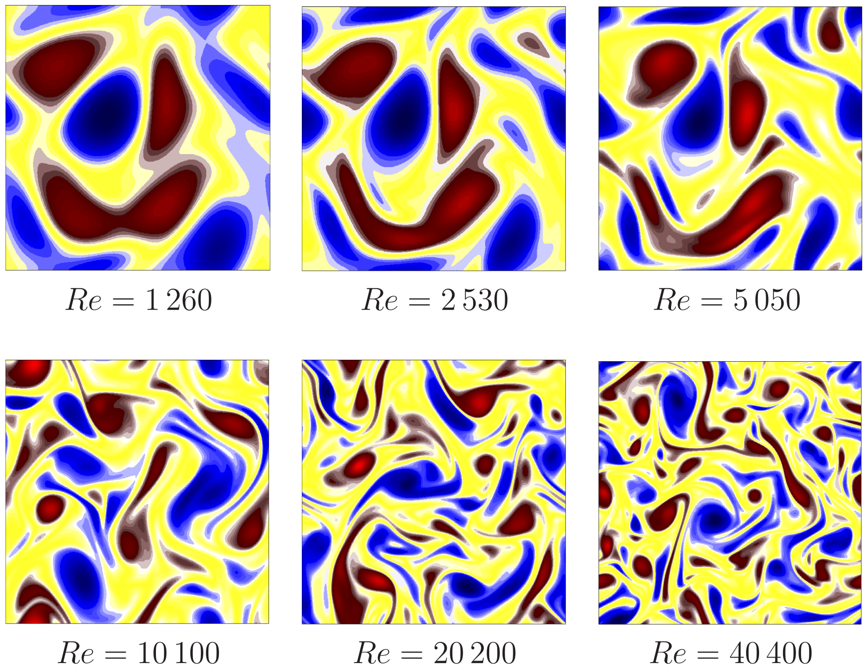

Figure 1: Coherent vorticity field: positive vorticity – 'red'; negative vorticity – 'blue'. Clearly, intermittency of the flow increases with the Reynolds number Re.

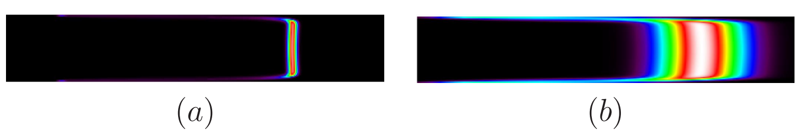

Figure 2: Comparison of a fully-Lagrangian parcel advection method with a flux-for Eulerian scheme. The error accumulates drastically in the Eulerian scheme. The concentration of an invading fluid injected into a confined channel containing a resident fluid is predicted at finite time t: (a) Parcel advection method, (b) Flux-form Eulerian scheme.

Teaching statement

Overview

My teaching philosophy stems from 5 years teaching as a full-time faculty member at Shahjalal University of Science and Technology (a degree granting institution), Bangladesh, 4 years teaching assistantship at McMaster University, Canada, and 2 years teaching assistantship at the University of Alberta, Canada. I supervised one MSc thesis in Shahjalal University.

Brief teaching records

- Mathematics 745, Fall 2006 (Mathematical and Computational Fluid Dynamics)

  Euler/Navier-Stokes equations and their properties; structures, boundary layers and turbulence; limits of small and large Reynolds number; techniques for the numerical solution; finite difference/volume techniques on collocated/staggered grids; truncation error, consistency, convergence, stability, non-uniform grids and numerical oscillations; efficient treatment of boundary layers and high Reynolds number flows; pressure correction scheme.

  (presented lectures for one week and graded exams/assignments)

- Mathematics 2T03, Winter, 2006 (Numerical Linear Algebra)

  Introduction to MatLab; Numerical solution of linear systems of equations; matrix and vector norms; sensitivity, conditioning, convergence and complexity; direct and iterative methods for linear systems; eigenvalues and eigenvectors; least squares; QR factorization; Householder transformation.

  Software: MATLAB

- Mathematics 3C03, Fall 2005 (Mathematical Physics I)

  Differential equations in physics and engineering; Eigenvalue problems; Normal mode solutions; Ordinary differential equations; Power series solutions about ordinary and regular singular points; Sturm-Liouville problems; Fourier series expansions; Solution of partial differential equations by separation of variables; Wave and heat equation; Laplace's equation; Schrdinger equation; Laplace transform, Fourier transform, and their applications.

  (tutorials)

- Mathematics 4Q03/6Q03, Winter 2005 (Numerical Methods for Differential Equations),

  Interpolation and Approximation; Numerical differentiation and integration; Solution of initial-value problems - Single-step Euler and Runge-Kutta methods, Multi-step explicit and implicit Adams methods; boundary-value problems; Finite-difference methods for partial differential equations - Iterative methods for the Laplace equation, Explicit/implicit methods for the heat equation and wave equation; Advanced numerical methods - Finite-element methods, Spectral methods

  Primary Reference: 1) C. F. Gerald & P. O. Wheatley, Applied numerical analysis, Pearson, (2004) Supplemental Reference: 2) S. S. Rao, Applied numerical methods for engineers and scientists, Prentice Hall, (2002). 3) R. J. Schilling & S. L. Harris, Applied numerical methods for engineers using MATLAB and C, Brooks/Cole, (2000).

Software: MATLAB

- MAT-424: Techniques of Advanced Mathematical Methods. Main text book: *C. Bender and S. Orszag, Advanced Mathematical Methods for Scientists and Engineers* (I taught this course for MSc students at Shah Jalal University).

  Local Analysis: Approximate solution of linear differential equation (LDE): Classification of singularity of homogenous LDE, asymptotic solution at irregular singular point of homogenous and non homogenous LDE, irregular singularity at infinity, asymptotic solution of LDE for large value of the independent variable. Approximate solution of nonlinear differential equation (NDE): Spontaneous singularity, approximate solutions of 1st order NDE, approximate solution of higher order NDE. **Perturbation methods**: Perturbation theory, regular and singular perturbation theory, perturbation method for linear eigenvalue problems. **Global analysis**: Boundary layer theory(BL): Introduction to BL theory, mathematical structure of BL, Higher order BL theory. **WKB theory**: The exponential approximation for dissipative and dispersive phenomena, conditions for validity of WKB approximation, WKB solution of inhomogeneous linear equations.

- Fluid Mechanics. Main text book: *P. Kundu, Fluid Mechanics* (for MSc students at Shahjalal University).

  Introductory motion: Stream lines and path lines, hydrodynamic pressure, Bernoullis theorem, adiabatic expansion. **Equation of motion**: Equation of continuity, equation of motion of inviscid liquid and Bernoullis equation, steady motion and conservative forces, circulation and Kelvins theorem, vorticity, irrotational motion and velocity potential, the energy equation, kinetic energy and Kelvins minimum energy theorem. **Two dimensional motion**: rate of change of vorticity, stream function and pressure equation, streaming motions, complex potential and complex velocity, stagnation points, circle theorem, motion past a cylinder, Joukowaski transformation, Blasius theorem. Two dimensional source and sink, doublets, combination of source and stream, source and sink of equal strength, source and sink in a stream, the method of image, source outside a cylinder. **Vortex motions**: Vortex lines, tubes and filaments, rectilinear vortex, circular vortex, and vortex doublets, kinetic energy of a system of vortices, vortex in or outside of a circular cylinder, vortex sheet, single infinite row of vortices and Karmans vortex street. **Three dimensional motions**: Three dimensional axi-symmetric motions and Stokes stream function, three dimensional sources in a uniform stream, Butlers sphere theorem, sphere in a stream and moving cylinders. **Hydrodynamic waves**: Mode of energy transmission, mathematical representation of wave motion and conditions at the free surface, surface waves, speed of propagation and wave length, progressive and standing waves, kinetic energy of waves, group velocity and wave at interface.

Teaching Methodology

While teaching in Shah Jalal University of Science and Technology, I needed to follow the brief syllabus prescribed by the Department. The syllabus of a course usually guides to achieve the final goal of the course. I prepare a detailed course outline that describes the step–by–step procedure of achieving the goal of a course. I like to describe my teaching method into listening, understanding, discussion, and practice. During a lecture, I explain the topic very clearly with examples. For example, to explain the limit of a function in a calculus class, rather than writing down the *mathematical definition* of limit, I first explain what a limit means in calculus and how to see limit in the real life. Once the students pass through the stage of listening and understanding, I write down the definition so that they can take notes. Right after that I go for a quick discussion *via* question and answer. This is how I enjoy teaching. At the end of lecturing on a topic, I usually recommend a few practice problems.

I found that the way of teaching, where one quickly writes down on the black board and posts practice problems, is not the effective method of teaching. In that case, students have to listen to what the teacher explains and to take notes of what the teacher writes down at the same time. The outcome of such teaching is that they get pages of *important* lecture notes only but fails to understand the topic.

My ideas about teaching are all oriented around the belief that learning is essentially an individual process. In other words, the degree to which we can learn something depends primarily on our own innate ability and the amount of work we put into learning, e.g., through reading, thinking, and working problems. I believe that there is actually little possibility of transferring the understanding in one mind directly into another mind. This is not to say lecturing is unimportant. It is just that there is more to lecturing than just being a method for getting notes down into the students notebooks.