TEQIP School on Computational Methods in Engineering Application
April 12-16, 2016
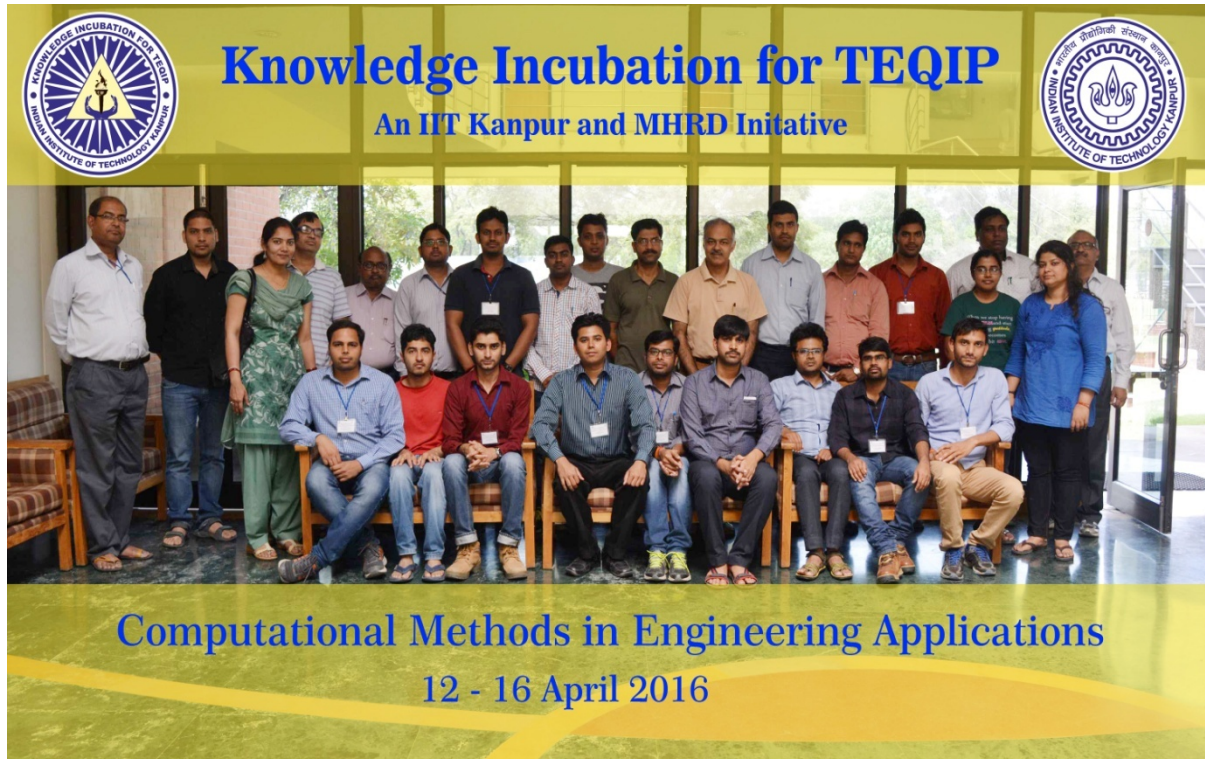
TEQIP School on Computational Methods in Engineering Applications was organized by KIT, IIT Kanpur. The aim of the school was to impart basic level courses for the various computational methods used in the area of solid and fluid mechanics. In this school, emphasis was given on the basic understanding of these methods through the lectures or talks from the experts in the respective fields. The faculties from IITs and Aligarh Muslim University, Aligarh who are working in this field delivered the talks related to new developments in these methods and their applications in engineering analysis and research. Furthermore, to get a practical feeling, sessions were organized for writing computer codes in any suitable programming language. Also hands-on sessions for usage of commercial software were arranged.

Topics Discussed

- Introduction to numerical methods for solution of PDEs, Variational methods and Introduction to one-dimensional Finite Element Method formulation for axial bar problem; extension to beam-bending, torsion and bending-torsion coupling.

- Families of shape functions, Numerical Integration, Physical and Master element concept and mapping, element stiffness and load vector calculation.
- 2D FE problem formulation for second order elliptic partial differential equations in terms of single variable (heat conduction) and two-variables (planar elasticity), 3D FE problem formulation for second order elliptic partial differential equations.
- Blending function basedFamilies of shape functions, Numerical Integration, Physical and Master element concept and mapping (affine, isoparametric,), element stiffness and load vector calculations.
- Plate theories for classical and laminated plates – weak formulation and element calculations
- Time dependent problems – parabolic and hyperbolic problems (transient heat conduction, dynamics and vibration of beams and plates); time-marching methods; Eigenvalue problems – free vibration problem for beams and plates; buckling of beams and plates,
- Non-linear FE – Introduction, Newton-Raphson method, model problem formulation (elastic bar on nonlinear springs, finite elasticity problem), load and time-stepping, stopping criterion
- Introduction to various elements of Computational Fluid Dynamics, Introduction of various computing strategies involved, Modelling Issues involved
- Grid Generation code writing and hands on experience with an existing code
- Introduction to Finite Difference Methodology, Development 2D solver for incompressible flow simulation: Formulation
- Introduction to Finite Difference Methodology, Development 2D solver for incompressible flow simulation

➢ Invited Talk:-
- Finite Element Methods
- Computational Methods in Engineering Applications
- Modelling of Metal Forming Processes Using Finite Element Method: Issues and Challenges.
- Numerical Methods for Hydrodynamic Stability
- Lock in/ Synchronization in Vortex Induced Vibrations

➢ Lab Session:-
- 1D FE code writing and hands on experience with an existing code
- Meshing/Discretization techniques – discussion on using hypermesh and other meshing/solid modelling software; Modelling these using FE packages
- Grid Generation code writing and hands on experience with an existing code

List of Speakers
- Dr. Arshad H Khan, AMU

- Dr. Rashid Zafar Ansari, AMU
- Prof. Tarun Kant, IIT Bombay
- Prof. NN Kishore, IIT Kanpur
- Prof. SundararajanNatarajan, IIT Madras
- Dr. Syed Fahad Anwer, AMU
- Prof. Sanjay Mittal, IIT Kanpur
- Dr. Hamid Hasan Khan, AMU
- Prof. Mirza Faisal S. Baig, AMU
- Prof. V Shankar, IIT Kanpur
- Dr. Noor Ul Huda, AMU
- Dr. PM Mohite, IITKanpur
- Prof. CS Upadhyay, IIT Kanpur
- Prof. PM Dixit, IIT Kanpur

Participating Institutes

Institute	Number of Participants
G.B. Pant University of Agriculture &Technology, Pantnagar	3
Cambridge Institute of Technology, Ranchi	2
Shiats DU, Allahabad	1
IFTM University of Moradabad	1
MNNIT Allahabad	9
Aligarh Muslim University	6
NIT Srinagar	1
HBTI, Kanpur	2
BIET Jhansi	2
IIT Roorkee	2
IIT Kanpur	2
BTKIT Dwarahat	2
Total	**33**

Workshop Schedule
April 12, 2016

Time	Event
8:30 – 9:00 AM	**Registration**
9:00 – 9:15 AM	**Inauguration of School**
9:15 – 11:15 AM	Introduction to numerical methods for solution of PDEs, Variational methods and Introduction to one-dimensional Finite Element Method formulation for axial bar problem; extension to beam-

	bending, torsion and bending-torsion coupling. *Dr. Arshad H Khan (AMU)*
11:15 – 11:30 AM	*Tea break*
11:30 AM – 1:30 PM	Families of shape functions, Numerical Integration, Physical and Master element concept and mapping, element stiffness and load vector calculation. *Dr. Rashid Zafar Ansari (AMU)*
1:30 – 2:15 PM	*Lunch break*
2:15 – 3:45 PM	**Invited Talk** 1: Finite Element Methods *Prof. Tarun Kant, IIT Bombay*
3:45 – 4:00 PM	*Tea break*
4:00 – 6:00 PM	1D FE code writing and hands on experience with an existing code- Lab work. *Dr. Arshad H Khan, Dr. Rashid Zafar Ansari and Students (AMU)*

April 13, 2016

Time	Event
9:00 – 11:00 AM	2D FE problem formulation for second order elliptic partial differential equations in terms of single variable (heat conduction) and two-variables (planar elasticity), 3D FE problem formulation for second order elliptic partial differential equations. *Prof. NN Kishore (IIT Kanpur)*
11:00 – 11:15 AM	*Tea break*
11:15 – 1:15 PM	Families of shape functions, Numerical Integration, Physical and Master element concept and mapping (affine, isoparametric, blending function based), element stiffness and load vector calculations, *Dr. PM Mohite (IITK)*
1:15 – 2:15 PM	*Lunch break*
2:15 – 3:45 PM	**Invited Talk:** TEQIP School on Computational Methods in Engineering Applications *Prof. SundararajanNatarajan (IIT Madras)*
3:45 – 4:00 PM	*Tea break*
4:00 – 6:00 PM	Plate theories for classical and laminated plates – weak formulation and element calculations *Dr. PM Mohite (IITK)*
7:30 PM onwards	*Workshop Dinner*

April 14, 2016

Time	Event
9:00 – 11:00 AM	Time dependent problems – parabolic and hyperbolic problems (transient heat conduction, dynamics and vibration of beams and plates); time-marching methods; Eigenvalue problems – free vibration problem for beams and plates; buckling of beams and

	plates, *Prof. NN Kishore (IITK)*
11:00 – 11:15 AM	*Tea break*
11:15 – 1:15 PM	Non-linear FE – Introduction, Newton-Raphson method, model problem formulation (elastic bar on nonlinear springs, finite elasticity problem), load and time-stepping, stopping criterion *Prof. CS Upadhyay (IITK)*
1:15 – 2:15 PM	*Lunch break*
2:15 – 3:45 PM	**Invited Talk 3**: Modeling of Metal Forming Processes Using Finite Element Method: Issues and Challenges. *Prof. PM Dixit (IIT Kanpur)*
3:45 – 4:00 PM	*Tea break*
4:00 – 6:00 PM	**Lab work** – Meshing/Discretization techniques – discussion on using hypermesh and other meshing/solid modeling softwares; Modeling these using FE packages *Dr. PM Mohite and students (IITK)*

April 15, 2016

Time	Event
10:00 – 11:00 AM	Introduction to various elements of Computational Fluid Dynamics, Introduction of various computing strategies involved, Modelling Issues involved *Dr. Syed Fahad Anwer (AMU)*
11:00 – 11:15 AM	*Tea break*
11:15 – 12:15 PM	**Invited talk 4:** Lock in/ Synchronization in Vortex Induced Vibrations *Prof. Sanjay Mittal (IIT Kanpur)*
12:15 – 1:15 PM	Grid Generation code writing and hands on experience with an existing code *Dr. Syed Fahad Anwer, Hamid Hasan Khan (AMU)*
1:15 – 2:15 PM	*Lunch break*
2:15 – 4:15 PM	**Lab work** – Grid Generation code writing and hands on experience with an existing code *Dr. Syed Fahad Anwer, Hamid Hasan Khan (AMU)*
4:15 – 4:30 PM	*Tea break*

April 16, 2016

Time	Event
9:30 – 11:00 AM	Introduction to Finite Difference Methodology, Development 2D solver for incompressible flow simulation: Formulation *Prof. Mirza Faisal S. Baig (AMU)*
11:00 – 11:15 AM	*Tea break*
11:15 – 12:45 PM	**Invited talk 5:** Numerical Methods for Hydrodynamic Stability *Prof. V Shankar (IIT Kanpur)*
12:45 – 2:00 PM	*Lunch break*
2:00 – 3:30 PM	Introduction to Finite Difference Methodology, Development 2D solver for incompressible flow simulation *Prof. Mirza Faisal S. Baig and Noor Ul Huda (AMU)*

3:30 – 3:45 PM	*Tea break*

Faculty Feedback

Workshop

Questions	Excellent	Good	Ordinary
Clarity of communication about workshop	03	01	01
Organization of the sessions	04	00	01
Quality of lectures	04	01	00
Quality of posters	02	01	00
Effectiveness of discussions	02	02	01
Effectiveness of learning experience	02	02	01
	Appropriate	*Short*	*long*
Duration of workshop	04	00	01
	Definitely	*Maybe*	*No*
Would you like to have more such sessions?	02	01	01
Would you like e-lectures by experts on special topics?	04	01	00
Suggest specific topic that you would like additional expert lectures on	➤ CNC, CAD ➤ Refrigeration system (VCRS) CNC(3D), Heat Exchanger. ➤ Non-Linearity.		
Additional Suggestions			

Teaching

Which subjects do you teach?	➤ Kinematics of machine manufacturing science working practice. ➤ CAD ➤ Plastic technology. ➤ Engg. Mechanics, basic thermodynamics, refrigeration, and air-conditioning. ➤ Fluid Mechanics, Heat Transfer, CFD
What is average student to teacher ratio in your institute?	➤ 40:01 ➤ 15:01 ➤ 20:01 ➤ 15:01 ➤ 25:01
Questions	*YES* · *NO*

Do you have additional support for teaching (tutors, graders, teaching Assistants, etc)?	03	02
Do you give class projects for UG classes?	05	00
Do you give class projects for PG classes?	03	00
Do you have sufficient resources for laboratory courses?	03	02

	Sufficient	*Inadequate*
Is the library/journal/e-connection support adequate?	02	03

	Definitely	*May* be	*No*
Would you like to have common (TEQIP) repository of course material?	04	01	00
Would you like to visit IITK to participate in and develop course material	04	01	00
Would you like to participate in creation of the repository material (course files/lab. Manuals/question bank/etc)	04	01	00

	e-courses	*Workshops*	*Content*	*none*
How can IITK effectively help you prepare for teaching?	03	03	01	00
How can TEQIP help improve your teaching?	➢ By providing technical inputs for various engineering subjects.			

Research

Questions	*Definitely*	*Maybe*	*No*
Would you like to visit an IIT for a visiting-faculty/ post-doctoral fellow, if offered (via-TEQIP)?	02	02	01
Would you like to share/use research infra-structure at IITK, if made available?	04	01	00
Would you like to conduct collaborative research with IITK?	04	01	00
Would you like lectures by experts (Indian and international) on niche research areas/topics?	03	02	00
Do you want special-topic conferences?	01	02	01

How can TEQIP help improve your research?	➢ By interacting with experts during workshops/ seminars ➢ By utilizing the lab facilities. ➢ Making effective use of library. ➢ By attending workshops, seminar & winter visiting research programme. ➢ By way of interaction.

Student Feedback

Workshop

Questions	Excellent	Good	Ordinary
Clarity of communication about workshop	07	12	00
Organization of the sessions	06	13	00
Quality of lectures	06	13	00
Quality of posters	06	11	02
Effectiveness of discussions	04	13	02
Effectiveness of learning experience	04	13	02
	Appropriate	Short	long
Duration of workshop	13	03	03
	Definitely	Maybe	No
Would you like to have more such sessions?	11	08	00
Would you like e-lectures by experts on special topics?	15	03	00

Suggest specific topic that you would like additional expert lectures on	- Numerical methods, CFD, chemical Engg. - Solving fluid mechanics problems with FEM. - Plastic deformation of materials. - Optimization technique. - Lab work on Ansys work bench. - Finite volume method for fluid flow problems. - Heat transfer based FEM study. - Lab session should be by expert on ansys. - Mathematics of FEM, lab work should be more. - Convective Heat Transfer - Simulation of flow areas bluff bodies like cylinder. - Latest research trends in bio-mechanical engineering. - Finite volume method with more lab sessions.
Additional Suggestions	- In lectures class, can be teach some fundamental of respective research area than reading/explain own research work. - Please increase the time of workshop or decrease the course content. The large course is not for short term. - Invited lectures should be in first half of the day. - Lectures should be more interactive, duration of lab work should be more. - There should be more workshop on latest topics. - Lectures must be short & crisp.

Learning

Questions	Yes	No
Do you get enough class projects?	12	06
Is the learning adequate?	19	00
Do you have sufficient resources for laboratory courses?	13	06

What is your area of specialization	- Production Engg. - Modelling & simulation. - Fluid mechanics. - Materials. - Mechanical Engg. - Production Engg. - Combustion. - Modelling & simulation study. - Manufacturing Sci & Tech. - Machining (Production) - Numerical solution of problems. - CFD, Fluid, Dynamics - CFD, Modelling, Simulation. - Computation fluid dynamic. - Refrigeration.	

	Sufficient	*inadequate*
Is the library/journal support/e-connection adequate?	15	01

	Definitely	*Maybe*	*No*
Would you like to have common (TEQIP) repository of course material?	16	03	00
Would you like to visit IITK to attend specialized courses?	18	01	00
Would you like MOOCS/e-resources based courses?	11	05	01

How can TEQIP help improve your learning?	- By providing more lab work facility. - It is enough to learn. - By providing readouts before workshop - By increasing lab sessions. - Give lab session & provide the software in colleges - TEQIP can help me learn more about FEM and different mathematical (Numerical) methods for solid part. I need more lab work to learn the different software like hypermesh, Abaqus etc. helpful in FEM, FVM, FDM - By conducting more hand-outs, lab sessions. - By organizing these type of workshop regularly. - Lectures on open source software.

Research

Questions	Definitely	Maybe	No
Would you like to visit an IIT for a short visit /internship/post- doctoral stint ,if offered (via TEQIP)?	18	01	00
Would you like to share/use research infra-structure at IITK, if made available?	18	01	00
Would you like to conduct collaborative research with IITK faculty?	14	05	00
Would you like lectures by experts (Indian and international) on niche research	15	02	00
Do you want special-topic conferences?	16	03	00
How can TEQIP help improve your research?	- By arranging more lab-works related to fluid mechanics problem. - It may be transparent by college by side. - Conducting core fundamental talk as well as hands on core area particular. - Please provide us guidance by experts & facility for experiments. - Software and analytical, - TEQIP can organize workshop on vibration problems & solving them by different methods using computer programming. - By arranging courses for FORTRAN language CFD courses & MATLAB - By organizing short term courses, conferences etc. - There should be more lab session regarding with latest application of FEM. - Via internship & Post-Docs. - Conferences on the CFD.		

Outcome

TEQIP School on Computational Methods in Engineering Applications 2016 has been successfully organized during **April 12- 16, 2016 at IIT Kanpur**. A class of computational methods is now an integral part of teaching and research. Various popular methods like finite element method (FEM), finite difference method (FDM), finite volume method (FVM), etc. are widely used in the analysis and design problems from mechanics. This school was to give the platform to young engineers to interact with experts in these areas and possibility to work with them either in the form of interns or joint students. This has worked well. Some participants have appreciated the lecture notes provided by the speakers. Furthermore, some participants have requested to organize a school again focussing on the basic learning for the implementation of computer codes, algorithms and related work based on these courses. The participants have expressed that this part is not covered in many of the institutes and left to the students for self exploration. In general, the school was successful in its aims and objectives.