



KNOWLEDGE INCUBATION FOR TEQIP, IIT KANPUR

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# Mechanics in Physics

June 23-27, 2014

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The five day workshop, “Mechanics in Physics”, conducted at IIT Kanpur under the patronage of TEQIP, opened up an excellent opportunity in bringing together physics teachers at varying seniority levels. They were all very keen to participate in the learning-teaching process. This workshop was open to all TEQIP affiliated institutes in India. The chief aim of the workshop was to motivate and empower the participants to articulate their eagerness for a contemporary Engineering Physics Curriculum. To this end several resource persons from within the IITK departments and outside were invited to participate.

## Topics Discussed

**Day 1 (June 23):** The academic program of the started with two seminars by Prof. Chakraborty and Prof. Srinivasan who explained the broad view of physics and its irreplaceable place in a rational society; and, also what the practical scenario is in the physics departments in the engineering colleges in India. After that Prof. Srinivasan introduced Newton’s laws in a lecture which was taken further by Prof. Chakraborty in two consecutive talks in which the confusing but indispensable topics on conserved quantities and pseudo-forces were covered. The day ended with Prof. Verma explaining how dimensional analysis could be made a part of curriculum in engineering physics.

**Day 2 (June 24):** On the second day, the emphasis was again on Newtonian mechanics. Prof. Srinivasan and Prof. Verma gave a total of 2 lectures and 2 tutorials in order to discuss system of particles, oscillators and angular momentum. The last lecture of the day was a gem by Prof. Srinivasan who explained how to set exam papers and how to truly evaluate a student for what he/she may know. The emphasis was also given in making the participants realize that project-based exams can contribute immensely to learning.

**Day 3 (June 24):** Prof. Bhattachargee gave two consecutive lectures to introduce special theory of relativity as a natural extension to Newtonian mechanics and showcased what would be an ideal way of making students understand the seemingly complex subject. The lectures were followed by a set of three lectures-cum-tutorials by Prof. Sarkar. Prof.

Bhattacharya and Prof. Verma who elaborated the subject more and, most importantly did an exercise on a paradox in special relativity to highlight what goes in to clarify/resolve the counter-intuitive nature of the subject.

**Day 4 (June 24):** The day again saw Prof. Bhattacharjee giving two lectures showing how quantum mechanics can be seamlessly integrated in a course on mechanics and what is the importance of the subject. He introduced Schrödinger's equation and Heisenberg's uncertainty principle — a topic which was further elaborated by Prof. Srinivasan in a subsequent lecture. The lectures concluded with SG giving a tutorial on the elementary aspects of the subject and he also highlighted few topics of current interest to the researchers of the field. Later in the day Prof. Sudeep Bhattacharjee showed the participants 1st year physics lab at IITK and explained to them in details various experiments that students can do.

**Day 5 (June 25):** The day mainly continued with discussion on quantum mechanics. Prof. Sarkar and Prof. Bhattacharya in three lectures solved the textbook problems of particle in a box, simple harmonic oscillator and hydrogen atom. They showed how compactly these topics can be covered in a first year class. Prof. Bhattacharya complemented the lectures with yet another tutorial on the subject. Towards the end of the day, Prof. Sharma gave a talk on what the expectations of engineers are from an engineering physics coursework. The workshop ended with an apt talk by Prof. H.C. Verma who explained, using simple demos, how students can be enthused into 'feeling' physics and doing it in right spirit.

### LIST OF SPEAKERS

- Dr. Jayanta Kumar Bhattacharjee, HRI Allahabad
- Dr. Sudeep Bhattacharjee, IIT Kanpur
- Dr. Kaushik Bhattacharya, IIT Kanpur
- Dr. Sagar Chakraborty, IIT Kanpur
- Dr. Saikat Ghosh, IIT Kanpur
- Dr. Tapobrata Sarkar, IIT Kanpur
- Dr. Ishan Sharma, IITK Kanpur
- Dr. K. Srinivasan, Toronto
- Dr. H. C. Verma, IIT Kanpur
- Dr. Mahendra Kumar Verma, IIT Kanpur

### PARTICIPATING INSTITUTES

Institute	Number of Participants
PEC University of Technology, Chandigarh	1
L.N.M.S. College, Birpur	1
UIET, MDU, Rohtak	1
HBTI, Kanpur	2
SVNIT , Surat, Gujarat	3
Heritage Institute of Technology ,Kolkata	2
Government Engg. College Jhalawar, Rajsthan	1
BMS College of Engineering, Bangalore	3
Narula Institute of Technology	2
Bankura Unnayani Institute of Engineering	2
Muzaffarpur Institute of Technology, Bihar	1
Govt. Women Engg. College Nasirabad Road	1
L.E. College Morbi	1
Institute of Chemical Technology ,Mumbai	1
Vasavi College of Engineering Ibrahimbagh,	3
National MEMS Design Centre PSG College	5
SIDDAGANGA Institute of Technology Tumkur.	3
Shantilal Shah Engg. College ,Bhavnagar, Gujrat	3
Aditya Institute of Tech. & Management	1
Sree Vidyanikethan Engg. College Sree Sainath	1
Govt. College Of Technology .Coimbatore	2
Thagarajar College of Engg. Madurai (TN State)	2
Govt. College of Engg. Bargur, Krishnagiri (T.N.)	1
NIT, Raipur	1
<b>Total</b>	<b>44</b>

### SCHEDULE OF THE WORKSHOP

**June 23, 2014**

Time	Event
9:30 AM – 10:30 AM	<b>Seminar</b> Prof. Sagar Chakraborty and Prof. K.Srinivasan
10:30 AM – 11:00 AM	Tea Break
11:00 AM – 12:00 Noon	<b>Model Lecture, Newton's laws</b> Dr. K.Srinivasan
12:15 PM – 1:15 PM	<b>Model Lecture, Conserved quantities</b> Dr. Sagar Chakraborty
1:15 PM – 3:00 PM	Lunch Break

3:00 PM – 4:00 PM	<b>Model tutorial, Frames of reference</b> Dr. Sagar Chakraborty
4:00 PM – 4:30 PM	Tea Break
4:30 PM – 5:30 PM	<b>Model tutorial, Dimensional analysis</b> Dr. Mahendra Kumar Varma

**June 24, 2014**

<b>Time</b>	<b>Event</b>
9:30 AM – 10:30 AM	<b>Model lecture, System of particles I</b> Dr. K. Srinivasan
10:30 AM – 11:00 AM	Tea Break
11:00 AM – 12:00 Noon	<b>Model Lecture, System of particles II</b> Dr. K. Srinivasan
12:15 PM – 1:15 PM	<b>Model Lecture, Oscillators</b> Dr. Mahendra Kumar Verma
1:15 PM – 3:00 PM	Lunch Break
3:00 PM – 4:00 PM	<b>Model tutorial, Angular Momentum</b> Dr. Mahendra Kumar Verma
4:00 PM – 4:30 PM	Tea Break
4:30 PM – 5:30 PM	<b>Model exam questions, Learning in Exam-hall</b> Dr. K. Srinivasan

**June 25, 2014**

<b>Time</b>	<b>Event</b>
9:30 AM – 10:30 AM	<b>Seminar, Classical to Relativistic in Classroom</b> Dr. Jayanta K Bhattacharjee
10:30 AM – 11:30	Tea Break
11:00 AM–12:00 Noon	<b>Model Lecture, Lorentz Transformations</b> Dr. Jayanta K Bhattacharjee
12:15 PM – 1:15 PM	<b>Model Lecture, Relativistic Kinematics</b> Dr. Tapobrata Sarkar
1:15 PM – 3:00 PM	Lunch Break
3:00 PM – 4:00 PM	<b>Model tutorial, Generic examples</b> Dr. Kaushik Bhattacharya
4:00PM – 4:30PM	Tea Break
4:30PM – 5:30PM	<b>Model tutorials, Paradoxes</b> Dr. Mahendra Kumar Varma

**June 26, 2014**

<b>Time</b>	<b>Event</b>
9:30 AM – 10:30 AM	<b>Seminar, Classical to Quantum in Classroom</b> Dr. Jayanta K Bhattacharjee
10:30 AM – 11:30	Tea Break
11:00 AM–12:00 Noon	<b>Model lecture, Schrodinger equation</b> Dr. Jayanta K Bhattacharjee
12:15 PM – 1:15 PM	<b>Model lecture, Uncertainty Principle</b> Dr. K. Srinivasan
1:15 PM – 3:00 PM	Lunch Break
3:00 PM – 4:00 PM	<b>Model tutorial, Generic examples</b> Dr. Saikat Ghosh
4:00PM – 4:30PM	Tea Break
4:30PM – 5:30PM	<b>Model tutorial, Generic examples</b> Dr. Saikat Ghosh

**June 27, 2014**

<b>Time</b>	<b>Event</b>
9:30 AM – 10:30 AM	<b>Model Lecture, Particle in a Box</b> Dr. Tapobrata Sarkar
10:30 AM – 11:30	Tea Break
11:00 AM–12:00 Noon	<b>Model lecture, Simple harmonic Oscillator</b> Dr. Tapobrata Sarkar
12:15 PM – 1:15 PM	<b>Model lecture, Hydrogen Atom</b> Dr. Kaushik Bhattacharya
1:15 PM – 3:00 PM	Lunch Break
3:00 PM – 4:00 PM	<b>Model tutorial, Generic examples</b> Dr. Kaushik Bhattacharya
4:00PM – 4:30PM	Tea Break
4:30PM – 5:30PM	<b>Physics related demonstrations</b> Dr. H.C Verma

### Summary of Faculty Feedback

Questions	Excellent	Good	Ordinary
Clarity of communication about workshop	33	5	0
Organization of the sessions	33	5	0
Quality of lectures	25	11	1
Quality of posters	Na	Na	Na
Effectiveness of discussions	11	24	2
Effectiveness of learning experience			
	Appropriate	Short	long
Duration of workshop	34	03	0
	Definitely	Maybe	No
Would you like to have more such sessions?	27	08	02
Would you like e-lectures by experts on special	31	05	02
Suggest specific topic that you would like additional expert lectures on	<ul style="list-style-type: none"> <li>• Electrodynamics, Field Theory.</li> <li>• Nuclear fission, fussion, CNO cycle, pp chain</li> <li>• Engg. Mechanics</li> <li>• Material science, computational physics</li> <li>• Electrodynamics, stat-mech, multibody problems in QM, waves and optics, solid state physics.</li> <li>• DFT, Eigen value problem, distribution dependent physical quantities.</li> <li>• Statistical Mechanics.</li> <li>• Demonstration of instruments.</li> <li>• Quantum Mechanics.</li> <li>• Solid state physics, statistical mechanics.</li> <li>• Thermodynamics, electrodynamics.</li> <li>• Electromagnetism.</li> <li>• Mathematical simulation, statistical physics.</li> <li>• Simulations and some fluid mechanics problem</li> <li>• Fundamentals and statistical mechanics (material science), thermodynamic potentials.</li> <li>• Fluid mechanics and Thermodynamics.</li> <li>• Fluid dynamics</li> <li>• Quantum, Mathematical Physics.</li> <li>• Optics, semiconductors, superconductors.</li> <li>• Quantum Mechanics applications.</li> <li>• Material science.</li> <li>• Fibre optics, Magnetism, Crystal structure.</li> <li>• Optics, fibre optics</li> <li>• EM Theory, Material Science.</li> </ul>		

	<ul style="list-style-type: none"> <li>• Uncertainty Principle.</li> <li>• Fluorescence spectroscopy and its applications.</li> <li>• Crystallography: synthesis, applications, characteristics.</li> <li>• Photonics, science of materials.</li> <li>• Solid state physic, photonics, Science of materials, Mat lab.</li> </ul>
<p style="text-align: center;">Additional Suggestions</p>	<ul style="list-style-type: none"> <li>• Please make available the hand outs just before or after the lecture.</li> <li>• A little bit of nuclear astro physics should be taught, hand out should be available.</li> <li>• More frequent courses.</li> <li>• Campus visit to all the labs could have been arranged.</li> <li>• Jump straight to QM/Relativity.</li> <li>• It would be better if some lab sessions are included.</li> <li>• Some hands on Experiments related to classical and quantum mechanics.</li> </ul>

**Teaching**

<p>Which subjects do you teach?</p>	<ul style="list-style-type: none"><li>• Physics in Engineering</li><li>• Electrodynamics, sound</li><li>• Physics</li><li>• Mechanical Engineering.</li><li>• Atomic, molecular and nuclear physics.</li><li>• Applied physics, Materials Science.</li><li>• General Physics</li><li>• Engg Physics, Engg. Mechanics.</li></ul>
<p>What is average student to teacher ratio in your institute?</p>	<p>50:1 50:1 30:1 12:1 20:1 20:1 60:1 15:1 20:1 230:3 60:1 20:1 16:1 15:1 20:1 60:1 15:1 30:1 20:1 20:1 30:1 30:1 15:1 15:1 15:1 30:1 65:1 15:1 15:1 15:1 80:1 20:1 30:1 16:1 16:1</p>



Questions	YES		NO	
Do you have additional support for teaching (tutors, graders, teaching Assistants, etc)?	17		17	
Do you give class projects for UG classes?	22		15	
Do you give class projects for PG classes?	13		24	
Do you have sufficient resources for laboratory courses?	20		17	
	Sufficient		Inadequate	
Is the library/journal/e-connection support adequate?	20		17	
	Definitely	May be	No	
Would you like to have common (TEQIP) repository of course material?	25	11	01	
Would you like to visit IITK to participate in and develop course material (existing or new)	31	06	00	
Would you like to participate in creation of the repository material (course files/lab. Manuals/question bank/etc)	33	04	00	
	e-courses	Workshops	Content	none
How can IITK effectively help you prepare for teaching?	21	22	11	00
How can TEQIP help improve your teaching?	<ul style="list-style-type: none"> <li>• By Providing Lab &amp; training, workshop.</li> <li>• By training.</li> <li>• By developing infrastructure and providing faculties with more exposure to better institution.</li> <li>• Organizing workshop on one particular topics for many days.</li> <li>• By attending such workshop we get awarded.</li> <li>• The exposure in the present programme will have a direct positive impact in my teaching methodology.</li> <li>• By participating workshop like this.</li> <li>• By conducting more workshops.</li> <li>• Request to provide course material, lectures in the form of PPTs and videos.</li> </ul>			

## Research

Questions	Definitely	Maybe	No
Would you like to visit an IIT for a visiting-faculty/post-doctoral fellow ,if offered(via TEQIP)?	30	06	00
Would you like to share/use research infrastructure at IITK, if made available?	34	02	00
Would you like to conduct collaborative research with IITK?	33	03	00
Would you like lectures by experts (Indian and international) on niche research areas/topics?	25	07	02
Do you want special-topic conferences?	24	11	00

How can TEQIP help improve your research?

- By availing basic facilities like internet, library at institute.
- Allowing us for characterization techniques.
- By providing funding for equipments.
- Through visiting faculty program.
- My research is focussed on material science. The clear understanding of quantum Mechanics will help me understanding spectroscopic characterization of materials.
- By organizing conference on the focused area.
- By organizing National, International conferences, financial support to do research
- Knowledge enhancement by attending (domain) workshop like this, conference (like this), conferences, seminars.
- Improvement in teaching-learning process through pedagogy training.
- Financial support to procure some basic equipment to start research work.

## **OUTCOME**

In this workshop the contemporary aspects of teaching mechanics in a Physics course were discussed. The workshop revealed the anxiety and the enthusiasm of the participants to improve the curriculum. Many participants suggested a sequel to this workshop in another important branch of physics of relevance to engineering and technological disciplines. It was expressed by feedbacks from participants that a regular exposure to programs like these will have a direct positive impact on teaching methodology of all the participating faculty members.