REPORT ON THE REFRESHER COURSE ON DESIGNING EXPERIMENTAL PROJECTS IN PHYSICS

Venue: Midnapore College, Medinipur, West Bengal
Date: 8-21 October, 2014

I. INTRODUCTION
A Refresher Course entitled “DESIGNING EXPERIMENTAL PROJECTS IN PHYSICS” was organized by the three Academies of Sciences in association with Midnapore College (Autonomous) and the Indian Association of Physics Teachers. The objective was to popularize experimental projects at UG and PG levels. For this purpose, in this 14-day Course the participants were given an academic programme of performing 15 thought-provoking experiments from the Experimental Kit, developed by Professor R Srinivasan and his team on behalf of the Indian Academy of Sciences, Bangalore. These innovative experiments were ideal to help performers to consider the know-how of such experiments. Besides these experiments a group of developed project experiments were also arranged in working conditions to illustrate how themes had been conceived and innovative experiments designed from them.

As scheduled, the materials and equipment for 12 experiments were received from Messrs Ajay Sensors and Instruments, Bangalore. Other experiments, namely flexural vibration, high resistance by leakage and B-H loop by integrator circuits, were developed following the Manual prepared by R. Srinivasan with some variation here and there, as the circuits were not exactly known. Even some errors were noticed in a few experiments caused during transportation. Thanks to our technical staff and resource persons these were fixed. Consequently, the participants did not find any difficulty to complete these experiments. At the end of the day, they suggested some innovations in physics experiments, and a brief account of these will be given later. The Participants and Resource Persons made some constructive comments on scientific basis, some even proposed alternative procedures which they thought would give parallel effect, if not better procedural and theoretical understanding of the concepts enshrined in the thematic scheme of the experiments. A list of the Resource Persons appears at the end of this report.

Altogether 31 applications were received from UG/PG teachers from different parts of the country for participation in the Course. Out of these, 30 were selected for participation. But on the inauguration day only 22 teachers appeared though arrangements were made for all the
selected participants. Again on the third day one participant fell ill and he had to discontinue. With 10 students, the total participants were 31 in number.

II. DAY TO DAY ACCOUNT OF THE COURSE

Day 1 (8 October, 2014)

Registration of the participants took place from 0830 to 0930 hrs. The participants were then guided to visit the labs to see the arrangement of the experiments. The inaugural function began at 11 am with Prof S N Bag (Teacher-in-Charge, Midnapore College) in the Chair as President. Dr A Thander, (Head, Department of Physics, Midnapore College and Joint Course Coordinator) introduced Bag along with Professor A K Raychaudhuri (former Director and Professor Emeritus, S N Bose National Centre for Basic Sciences, Kolkata) who inaugurated the Course. Dr P K Chakrabarti (Former Principal, Midnapore College, and an expert in physics experiments) was the chief guest. Bag welcomed the audience on behalf of the college and assured all help to make the Refresher Course a grand success. Dr S C Samanta, (former General Secretary, IAPT and another Joint Course Coordinator) explained to the audience the objective of this two-week long programme. P K Chakrabarti also talked about the aims and objectives of the Course and the unique experiments included in it. Inaugurating the Course, Raychaudhuri expressed his satisfaction that a Course of its kind is being held for the first time in the Eastern part of the country and that too in a college. He congratulated the college for this endeavour and hoped that the Course would fulfil its objectives.

Raychaudhuri delivered his keynote address at 1200 noon, which was in perfect tune with the purpose of the Course and highly acclaimed.

After the lunch break, the participants started doing experiments in 15 groups consisting of 2/3 participants in each group, under the guidance of the experts. The Lab session continued till 1730 hrs.

Day 2

The day began at 0930 and the lab session commenced and continued till lunch break. In the afternoon session, there were two talks one by Dr G Bhattacharya and another by S Datta. Bhattacharya, an expert in electronics, explained to the audience the conceptual aspect as well as
the application of lock-in-amplifier in physics experiments; in fact he suggested some project experiments based on it. S Datta, (an expert in the physics of harvesting solar energy) highlighted his findings on the physics of semiconductor diodes and its different facets. He also suggested some project ideas related to this field. After seven long hours the participants had multitudes of queries, the experts tried to answer them with proper explanation. This interaction session continued till the end of the day.

Day 3

As usual the day started with the lab session at 0930 and continued till lunch break. Drs S Chakrabarti and D Syam delivered their talks during the post-lunch session. In his talk, Chakrabarti narrated his self-designed simple experiments through PPT on application of Bernoulli’s and Poiseullies theorems in case of air flow, leading to measurement of viscosity of air. Syam focussed his talk on critical analyses of some of the experiments arranged for the Course. The participants interacted enthusiastically over the problems and prospects of the experiments they performed.

Day 4

After the morning lab session, S Minhaz Hossain gave a wonderful talk at the post-lunch session through live demonstration on the use of webcam in performing basic physics experiments. The participants appreciated his talk and found confidence in doing a number of projects following such an approach. As in the previous day, they interacted enthusiastically to resolve their problems.

Day 5

The day started under the threat of impending danger of Hudhud. But the participants started the day at 0930 like earlier days, but this time with less number of experts. This was because the participants themselves turned into Resource Persons, so that the programme continued with less number of experts. There was no talks and the participants continued their lab activities unhindered till the end of day.
A note was circulated among the participants, on behalf of the Joint Course Coordinators, to communicate the tasks ahead in the coming days. It contained also the information on the publications of Science Academies with a request to subscribe to the journals.

**Day 6**

On the sixth day the participants started doing experiments and continued till 1630, when Prof P K Majumdar gave a beautiful talk on the use of Newton’s ring experiment to observe and study the hyperboloid fringes produced in Cornu’s experiment for measuring elastic constants of glass/plastic material.

Dr A Chakrabarti, who participated intensively and extensively in the preparatory stage, joined the Course as a Resource Person.

**Day 7**

Perhaps as an after-effect of Hudhud, the day started with a heavy downpour; consequently, the morning lab session started a bit late. As there was no talk, the lab session continued for the whole day.

**Day 8**

The sky was overcast but there was no rain to disturb the sessions; the lab session continued till 1530 hrs when participants were guided to acquaint with the developed project experiments, arranged in the IAPT-Midnapore College Centre for Scientific Culture so that they can have some project ideas. At 1615 pm S C Samanta gave a talk entitled “Project Works—Complementary to Lab Programmes”.

Through interaction it was decided that presentation on project ideas needed around seven and a half hours for all the 15 groups of participants, with half an hour for each group. So the time-schedule was changed and only the three afternoon sessions from 18 to 20 October (day 11 and 12) were fixed for these presentations.
Day 9

The lab session continued for the whole day from 0930 till 1730. A note from Syam containing some project ideas was distributed. Dr B N Das, returned to join the Course.

Day 10

In the morning lab session the participants worked as before; some continued with the Academy kit experiments, some tried with the experimentation of their project ideas. In the afternoon session A Dasgupta, (Dean of Academic Affairs, IISER, Kolkata) delivered a talk on the theme of simulating, designing and developing experiments with digital camera and software tools. After the talk, the participants interacted among themselves in an Open Session, on the performance of each experiment undertaken by each group. Dr P Panchadhyayee (P K College Contai, East Midnapore) coordinated the interaction session.

Day 11

This day also some participants were busy giving final touches to complete the Academy kit experiments, some were busy preparing for their presentation of project ideas in the afternoon session. The afternoon session started with a talk by A Chakrabarti, where he shared his experience on the problems he used to face while supervising lab programmes of his students. After this talk the participants began their presentations on the project work.

Dr S. Ghosh (Department of Physics, Vidyasagar University) talked on the project work related to the preparation and studies with optoelectronic materials like graphene in UG/PG lab. He emphasized that there is a huge scope for developing innovative experiments in this domain. The next presentation was by Drs S Chandra and T Mishra (both from Sabang Sajanikanta Mahavidyalaya) on active filters using OPAMP. It was an extension of the Academy kit experiment on passive filters. Their aim was to make passive filters more theoretical (i.e gain vs frequency graph is a step function) using OPAMPS. Debasis Jana (an UG student) presented his project work on the construction of a function generator and its use to perform certain experiments like measurement of self-inductance following Anderson bridge method. The last presenter of the day was also an UG student (Purushottam Barik) who performed an experiment for measuring thermal coefficient of linear expansion. For this purpose, he used laser diffraction
technique to measure extension in length and thermocouple along with an OPAMP circuitry to measure change in temperature.

Experts like Drs S Chakrabarty, D Syam and R R Pal made certain pertinent comments to enrich the session.

Day 12

After the lab session in the morning some of the participants presented their project experiments during the post-lunch session. The teacher-participants (T Pal, T. Kar, P. Das, S. Datta, P Panchadhyayee, M. Nanda Goswami, B Das, Kriti Sahoo, L Baruah, S Shee and S. Pradhan) and student participants (Arijit Mahapatra, Panchanan Sahoo and Suman Karan) presented their project experiments. T Pal (Midnapore College) presented some project experiments on phototransistor. Though she started her work as a project for her UG student with a power transistor as a phototransistor, her PhD students are now continuing this work albeit with different objectives. T Kar (Kharagpur College) presented her project experiments on the variation of resistance with pressure. P Das (Midnapore College) and S Datta (Chanrakona College) presented theoretical and experimental analyses of the depression profile of a beam clamped at one end; but their values for Y at different points of loading (without any external load) were not at all satisfactory. Nanda Goswami (Midnapore College) studied the hysteresis loop of a ferromagnetic specimen using a.c. source; he also told the audience that he would carry out an experiment to study the variation of coefficient thermal expansion around Curie temperature. P Panchadhyayee (P K College, Contai) explained how mirror sprayed with powder can produce a system of circular fringes when illuminated with laser and leads to measurement of the refractive index of glass, the substrate of the mirror. K. Sahoo (Egra College) told about his experiments with hollow prism to study the optical properties of organic compounds. S Shee and S Pradhan, (both from Midnapore College) presented their experiment to measure the viscosity of a liquid with an oscillating plate and suggested some extension also.

Day 13

After the lab session in the morning upto 1200 noon, the afternoon session began with a talk by D Syam who spoke on the theory of the hyperboloid fringes formed in Cornus experiment to
measure Young’s modulus; P Majumdar had already demonstrated in his talk how Newton’s ring apparatus can be used to perform Cornu’s experiment. After lunch Kalyan Mukhopadhyay (an ex-student of Midnapore College) talked about the experimentation and project work for understanding of physics. In the afternoon session, the selected participants (S. Manna, U Sarkar, M Chattopadhyay, S. Nandi, S. Chaudhury, S. Santra and R Pradhan) demonstrated their project experiments. Prof Manna (Raja Rammohun College) and Prof. Sarkar (Belonia College) told about their experiment on measuring $h$ using LED, but others disagreed with their experiment for theoretical reasons. Professors M Chattopadhyay and S Nandi (both from RBC College, Naihati) presented their experiments on motor principle and studies on ionization potential using flames. Professors Chaudhury and Santra had initiated an experiment for studying the variation of Young’s modulus with temperature; their initial findings are encouraging. Professor Rajib Pradhan actually had extended the study on the flexural vibration of the thin aluminium bar up to seventh order both theoretically and experimentally with good agreements. Amit Kumar Maity (A student) showed how he studied the Wheatstone’s bridges using the null detector he prepared as his project experiment. Another student (Subhendu) demonstrated how the Academy experiment for measuring capacitance could be extended to find the variation of dielectric constant of a liquid with temperature. With benzene his study is good, but it needs some careful measurement particularly around ice temperature.

At the end of the day, S Chakrabarty made some specific comments on the theory of the Academy kit experiment on thermal relaxation.

**Day 14 (October 21, 2014)**

Participants were requested to be present in the labs around 0830 to complete the experiments and report by 1000 for the special talk. Prof Ghosh delivered his lucid talk on designing of glass materials with required properties; the participants appreciated his talk. The talk was over by 1130 followed by a group photograph.

**Valedictory session**
The valedictory session began at 1145 and continued till lunch break. As the valedictory session is normally conducted by participants, P Panchadhyayee and M Chattopadhyay on behalf of the participants were requested to conduct.

S N Bag, A Ghosh, S C Samanta, A Thander, S Chakrabarti, Dr D Syam and A Chakrabarti were on the dais; Bag presided over the session. Panchadhyayee shared with the audience his own experience in the Refresher Course where everyone tried innovative experiments of the Academy kit in a conducive atmosphere in which all the logistics—human and material—were freely available and finally a number of new experiments had been generated. According to him this was a Refresher Course certainly with a difference. Chattopadhyay presented a song after highlighting the achievements in this Course. Panchadhyayee then invited Baruah, Sarkar, Nanda Goswami, Chandra (all teacher-participant)s and Debasis Jana and Suvendu Ghosh (student-participants) to present one by one their side of the story in turn. The summary of their narration was that this Refresher Course was an unique exercise with wonderful course content. In his address, S Chakrabarti, one of the Resource Persons, remarked that he learnt a lot through his participation. SC Samanta mentioned how the Course was conceived and designed; he expressed his satisfaction over the way it had been implemented. He expressed his gratitude to everyone concerned with the Course from Prof Indrani Bose, (President, IAPT) to the students of the college who toiled hard to make the Course a success. Finally, Bag thanked the everyone on behalf of Midnapore College and Thander thanked the Science Academies, IAPT, Midnapore College and all institutions and individuals without whom it would be impossible to organize the RC in Midnapore College. Some gifts were presented to the Course director, Jt Coordinators and Resource Persons on behalf of the participants. With the permission of the Chair, Panchadhayee called it a day and requested everybody to join for lunch before they left.

III. LIST OF EXPERTS, TECHNICAL STAFF AND THE DATES ON WHICH THEY WORKED

EXPERTS:

1. Dr P K Chakrabarti, Ex Principal, Midnapore College: PREPARATORY STAGE SEPT 17,18,29,30, OCT 5,6 AND IMPLEMENTATION STAGE: OCT 8,9,10,11,12, 20,21.
2. Dr S. Chakrabarti, Associate Professor (Retd), Maharaja Manindra Cahndra College, Kolkata, PREPARATORY STAGE: SEPT 13 & 14, IMPLEMENTATION STAGE: OCT 8,9,10,11,12,18,19,21
3. Dr D. Syam, Associate Professor (Retd), Barasat Govt College, Barasat, Kolkata, PREPARATORY STAGE: SEPT 13 & 14, IMPLEMENTATION STAGE: OCT 8,9,10,11,12,18,19,20,21
4. Dr A. Chakrabarti, Associate Professor (Retd), Chakdah College, Chakdah, Nadia, PREPARATORY STAGE: SEPT 12 & 13, OCT 5 & 6, IMPLEMENTATION STAGE: OCT 13,14,15,16,17,18,20,21
5. Dr G. Bhattacharya, Associate Professor, Ram Krishna Mission Vidyamandira, Belur Math, Belur, PREPARATORY STAGE: SEPT 13 & 14, IMPLEMENTATION STAGE: OCT 8,9,10
6. Dr S. Datta, Adjunct Professor IIEST, Shibpur, Howrah. PREPARATORY STAGE: SEPT 13 & 14, IMPLEMENTATION STAGE: OCT 8,9,10,11
7. Dr S. M. Hossain, Assistant Professor, IIEST, Shibpur, Howrah, PREPARATORY STAGE: SEPT 13 & 14, IMPLEMENTATION STAGE: OCT 8,10,11
8. Dr B.N. Das, Guest Teacher, Presidency University, Kolkata, PREPARATORY STAGE: SEPT 13 & 14, IMPLEMENTATION STAGE: OCT 8,9, 12,13
9. Prof R R Pal, Professor & Head, Department of Physics and Technophysics, Midnapore IMPLEMENTATION STAGE: OCT 8,11,12,18,19,20

The following Persons provided technical service throughout the implementation stage as well as two weeks prior to it for preparatory work: 1. Kali KInkar Raul; 2. Chandan Ghosh; 3. Arnab Dhara; 4. Ark Chaudhury.

IV. SCIENTIFIC ACHIEVEMENTS IN THE COURSE

A. The following experiments from the Academy kit had been developed by the technical staff and resource persons

1. B-H loop: This is an UG experiment to study the hysteresis loop in anchor ring set-up with ballistic galvanometer and solenoid which is generally used for calibration of the galvanometer. Only the integrator circuit had been developed to replace the ballistic
galvanometer; rest of the procedure was exactly the same as followed in the routine experiment in the UG lab of Midnapore College.

2. In the experiment of the measurement of high resistance (like 220 MΩ) by the method of leakage a voltmeter is used in conjunction with a unity gain OPAMP amplifier (OP27).

3. Flexural Vibration of an aluminium bar had been developed following the suggestions given in the Academy Manual.

4. Parallel arrangements were made for the experiments on passive filters as well as LCR circuits.

5. In order to study the Wheatstone’s bridge our students developed signal generator as well as null detector.

6. Only one oven was provided to study three different experiments; another oven was arranged with a variac to study Curie temperature in case of a ferroelectric material.

B. Experiments developed by experts and participants

1. P K Majmudar showed how Newton’s ring set-up can be used, after slight modification, to measure elastic constants of glass/plastic materials by Cornu’s method. Syam explained the theory of the hyperboloid fringes, used for measurement. Now, with its new look Cornu’s experiment can be done with Newton’s ring set up with a travelling microscope to measure transverse translation.

2. S. Chandra and Mishra extended the Academy experiments on passive filters so that the use of OPAMP makes the curves (gain vs frequency) like step functions.

3. S Ghosh showed how a modest UG lab can be used to prepare graphene and study its optoelectronic properties. Some of his students had done project experiments in this regard.

4. T Kar studied how resistance of some powder material varies with pressure.

5. T Pal reported that her students undertook project experiments on power transistor converted into a phototransistor. She further reported that some of her PhD students were working for their PhD thesis on phototransistor based on optoelectronic materials.
6. S Shee and S S Pradhan reported on an experiment to measure viscosity of a liquid studying the damping of oscillation of a plate in the liquid.

7. S Datta and P Das studied depression profile of an elastic beam clamped at one end and loaded at different axial points, both experimentally and numerically. But their results were not satisfactory.

8. M Chattopadhyay and S Nandi studied the motor principle and ionization in a flame but their studies were inconclusive.

9. M Nanda-Goswami reported his study on the B-H loop in a ferromagnetic material using a.c. and CRO. He mentioned that his study on temperature variation coefficient of thermal expansion of a ferrite rod around Curie temperature had shown some behaviour along expected lines but he would continue the study to obtain more definite results.

10. S. Manna and U Sarkar measured $h$ using LED and grating. But for theoretical reasons the participants were not satisfied with their experiment.

11. P Panchadhyayee reported his work on the formation of circular interference fringes when a laser illuminates a plane mirror sprayed with powder. From this study he got the refractive index of the glass the substrate of the mirror.

12. Sourav Chandra and S Santra tried to study the temperature variation of the Young’s modulus of the material of a beam. Their initial data showed that $Y$ decreases with temperature. They would pursue the study further.

13. K R Sahoo had done an optical experiment taking an organic liquid in a hollow prism for determining some properties of the liquid; but he could not complete the experiment to arrive at any conclusion.

14. R Pradhan had made an extensive theoretical study of the flexural vibration of a beam up to seventh mode; his experimental results conform well to the theoretical ones.

15. Suvendu Ghosh, (an MSc student), extended the Academy experiment for measuring the dielectric constant of a liquid, even at elevated temperatures. He found benzene behaving in expected manner but he could not complete the experiment with all details. Amit Maity (an UG student) developed a null detector and he used it to study some Wheatstone bridges with it.
16. Devasis Jana developed a function generator and used it to study Wheatstone’s bridges.

17. Three students (Panchanan, Purakayastha and Suman) made some interesting studies on Meldie’s experiment with an electromechanical oscillator developed by them. They also determined the value of \( Y \) for iron from this experiment.

C. Alternative Theoretical Approaches to some of the Academy Experiments

The participants and Resource Persons spent considerable time for conceptual understanding of the wonderful design of heat experiments particularly the experiments on thermal relaxation and Stefan’s constant. The views on these experiments are summarized in separate sheets.

V. Refresher Course, Science Academies and the IAPT: Some Concluding Remarks

Practically, all the teacher-participants and experts are Life Members of IAPT and some of them are very active in different IAPT programmes. As IAPT is associated with the training and selection programmes of the Indian teams for International and Asian Physics Olympiads, the exposure of its members to such a Course would be beneficial for identifying innovative experiments and resource persons with expertise in such innovations. So together with IAPT, the Science Academies can pursue such programmes more aggressively for preparing a base for scientific manpower in the country. One can remember, as is reported in the Preface of the Manual for the Academy kit, that Science Academies started its endeavour of Refresher Course in Experimental Physics in association with IAPT members. IAPT had shown through this programme that Refresher Courses could be organized with the theme “Designing Experimental Projects in Physics”. So the bonding between IAPT and Science Academies should be strengthened so that the right academic environment for basic research in the country can be ensured even in schools and colleges.

The central as well as the state governments are doing much for the improvement of science education in the country through programmes like Sarba Siksha Mission, INSPIRE etc. If organizations like IAPT work with the Academies, hand in hand, for
the orientation of the thousands of science teachers in schools to make them more comfortable and competent with the new procedure of imparting science education as enshrined in the National Curricular Framework, then it will be really a great job, indeed, for nation building in the true sense of the term.

**Programme Schedule for the RC Oct 8 to Oct 21, 2014:**

Except day 1, each day work will start at 930 hrs, after completing breakfast, and will continue up to 1730 hrs; Lunch break was from 1300 to 1400 hrs. Tea will remain ready, just outside the labs, at appropriate times, the participants will take in their discretion.

**Detailed time schedule:**

**Day 1 (October 8, 2014):** Registration: 8.30 AM to 9.30 AM  
Visit to lab for introduction: 9.30 AM to 11.00 AM  
Inauguration: 11AM to 11.45 AM: Keynote Address by Prof A Raychaudhury, Director, SN Bose National Centre for Basic Sciences, Kolkata: 11.45 AM to 1.00 PM.  
Introduction of the participants to the labs by the Resource Persons: 2.00 PM to 5.30 PM

**Day 2 (Oct 9, 2014):** Lab works: 9.30 to 1.00 PM  
Talk by Dr G. Bhattacharya: 2.00 to 3.15 PM  
Talk by Dr S Dutta: 3.15 to 4.30 PM  
Interaction: 4.30 to 5.30 PM

**Day 3 (Oct 10, 2014):** Lab works: 9.30 to 1.00 PM  
Talk by Dr S Minhaz: 2.00 to 3.15 PM  
Talk by Dr S Chakrabarti: 3.15 to 4.30 PM  
Interaction: 4.30 to 5.30 PM

**Day 4 (Oct 11, 2014):** Lab Sessions: 9.30 to 11.00 AM  
Talk by Dr D. Syam: 2.00 to 3.15 PM  
Talk by Dr S Chakrabarti: 3.15 to 4.30 PM  
Interaction: 4.30 to 5.30 PM
**Day 5 (Oct 12, 2014):** Lab Sessions: 9.30 to 1.00 PM  
Talk by Dr S Chakraborti: 2.00 to 3.00 PM  
Lab Sessions 3.00 to 5.30 PM

**Day 6 & 7 (Oct 13 & 14, 2014):** Lab Sessions: 9.30 to 5-30 PM

**Day 8 (Oct 15, 2014):** Lab Work 9.30 to 1.00 PM  
Special Lecture By Professor Aswini Ghosh: 2.00 to 3PM  
Talk By Dr S Samanta : 3.00 to 4.00 PM  
Interaction: 4.30 to 5.30 PM

**Day 9 (Oct 16, 2014):** Lab Works: 9.30 – 5.30PM

**Day 10 (Oct 17-2014):**  
Lab Works: 9.30 to1.00PM  
Talk by Dr A Dasgupta: 2.00 to 3.30 PM  
Open session for interaction among the participants: 3.30 to 5.30PM

**Day 11 (Oct 18, 2014):** Lab Works: 9.30 to 1.00 PM  
Talk by Dr A Chakrabarti:2.00 to 3.30 PM  
Presentation on project experiments by participants: 3.30 to 5.30 PM

**Day 12 (Oct 19, 2014):** Lab Session: 9.30 to 1.00 PM  
Presentation on project experiments: 2.00 to 5.30 PM

**Day 13 (Oct 20, 2014):** Lab Session: 9.30 to12 Noon  
Talk by Dr D Syam on hyperboloid fringes in Cornu’s experiment: 12.00 to 1.00 PM  
Presentation on project experiments: 2.00 to 5.30 PM

**Day 14 (21.10.2014):** Lab Works: 8.30 to 10.00 AM  
Special By Prof Aswini Ghosh: 10.00 to 11.45 AM  
Valedictory Session: 11.45 to 1.30PM  
Afterwards Lunch & Departure