Report on "Refresher Course in Experimental Physics"

The laboratory programs in the B.Sc (Physics) and M.Sc (Physics) courses in various universities in the country are in a poor state. In many colleges experiments recommended by the UGC in such programs are not being done. The Indian Academy of Sciences, Bangalore, entrusted the responsibility of developing simple, but effective, experiments of low cost with the aim of improving the laboratory programs in colleges and universities. In this Himalayan task Dr.Kaustubh R.S.Priolkar, Goa University, Prof.Sadique, Goa University, Goa, Dr.S.B.Gudennavar, Christ University, Bangalore and Prof.R.Srinivasan, Former Director, UGC-DAE CSR, Indore and Chairman, Refresher Course in Experimental Physics were actively involved in this course to motivate the participants. Participants were trained in doing the experiments and submit the results with the agreement of less than 5% and comparable with the physical quantities. The experiments were verified with the physical laws and illustrated physical principles besides yielding the values of physical quantities with reasonable accuracy. At the level of B.Sc and First year M.Sc the readings should be taken manually by a student so that he/she understands how the measurements are done. For example the student will realize that a thermocouple used to measure temperature will have a non-linear response, while a Platinum resistor will have a linear response. Automated experiments, in which the data are automatically acquired by a computer that corrects for the non-linearity of temperature response of a thermocouple, could be profitably introduced in the second year of the M.Sc program.

It was necessary to build some simple electronic circuits for carrying out the experiments, which we intended to develop. These circuits are analogue circuits based on simple and low cost IC chips, which are locally available.

The kits consist of

1. A regulated 30 V, 2A DC power supply.
2. An On-OFF temperature controller using Pt 100 sensor.
3. A constant current source working in two ranges: Low current 100 micro amp to 20 milliamp. Current remains constant to within 0.1% when the load varies to till the voltage across the load reaches 15 V. High Current: 20 mA to 0.5 amps continuous operation. Current remains constant within ±1% as the load is varied.
till the voltage across the load reaches a value of 24 V. Two numbers are provided in a kit.

4. A DC differential amplifier with three inputs. Amplification can be 10 or 100. Offset adjust pot and reversing switch are provided. Useful for measuring thermo-emfs. Two numbers are provided in a kit.

5. A capacitance meter for measuring capacitances up to 250 pf. Useful for measuring dielectric constant of non-polar liquids and dipole moment of acetone. DC output voltage is proportional to capacitance.

6. A signal generator capable of giving square, triangular and sinusoidal output. Frequency from 10 Hz to 50 kHz in four ranges. RMS amplitude variable from 0 to 7 Volts (peak to peak amplitude from 0 to 20 V). Panel meter indicates frequency up to 10 kHz and amplitude up to second decimal place. Two numbers are provided in a kit.

7. A power amplifier working in the audio range. The input is from the signal generator. It will drive a loudspeaker or a coil to generate an oscillating magnetic field.

8. An AC Bridge circuit with which Maxwell's, De Sauty's and Anderson's bridges can be realized.


10. A lock in amplifier working from 400 Hz to 10 kHz. Provides a DC output of about 1 V for an AC rms input of 200 microvolts. Taps are taken to illustrate how phase sensitive detection works. An internal calibration circuit is provided.

Experimental set-ups to work with the above circuits

1. A furnace going up to 300°C to be used with the regulated power supply and temperature controller.

2. An insert to the furnace to measure thermo-emf of a copper constanstan thermocouple and the forward voltage on a silicon diode at constant current to show their utility as temperature sensors.

3. An insert to measure the temperature coefficient of copper. It can be used with a sample of a semiconductor to measure its band gap.

4. A set up to verify Stefan’s radiation law and measure Stefan’s constant.
5. A set up to measure thermal and electrical conductivity of copper and find the Lorentz number.
6. A set up for thermal diffusivity of brass.
7. A capacitor box to verify the law of addition of capacitances using the capacitance meter.
8. A cylindrical capacitor to measure the dielectric constant of a non-polar liquid and the dipole moment of acetone using the capacitance meter.
9. A L-C-R box to
   (i) verify how the impedance of an inductance varies with frequency and find the inductance of a coil,
   (ii) to measure by how much the phase of the voltage relative to the current across an inductor varies with frequency and calculate the resistance of the inductor,
   (iii) to verify how the impedance of a capacitor varies with the frequency,
   (iv) to show that the impedance of a series resonant circuit is a minimum at the resonant frequency and
   (v) to show that the impedance of a parallel resonant circuit is maximum at the resonant frequency
10. A box for measuring a resistance below 1 ohm with the Lock in amplifier
11. A mutual inductance coil to show that the emf of the secondary differs in phase from the primary current by 90°, to show that the emf of the secondary is proportional to the frequency and the current through the primary. This is done with a lock in amplifier. The mutual inductance is a few micro-henries and this can be measured to an accuracy of 2 to 3% with a primary current of about a milli-amp.
12. Verification of Curie-Weiss law for the electrical susceptibility of a ferroelectric material.
THIRTEENH REFRESHER COURSE IN
EXPERIMENTAL PHYSICS

ALAGAPPA UNIVERSITY

(Accredited with 'A' Grade by NAAC)

SCHOOL OF PHYSICS

(UGC-SAP and DST-FIST supported)

7 – 22 May 2009

Sponsored by

INDIAN ACADEMY OF SCIENCES, BANGALORE

INDIAN NATIONAL SCIENCE ACADEMY, DELHI

NATIONAL ACADEMY OF SCIENCES OF INDIA, ALLAHABAD

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Coffee/Tea Break: 11:00 to 11:15 hrs and 15:30 to 15:45 hrs

Lunch break: 13:00 to 14:00 hrs
LECTURES

1. Dr. D’Sa
   (D’Sa1) Constant current source – Load regulation
   (D’Sa2) Temperature coefficient of resistance of Cu and band gap of semiconductor
   (D’Sa 3) Calibration of Si diode and Thermocouple against Pt sensor

2. Prof. Sadiq
   (Sadiq 1) Signal generator
   (Sadiq 2) Capacitance circuit
   (Sadiq 3) AC Bridges

3. Dr. K.R.Priolkar
   (KRP1) Thermal conductivity of Copper
   (KRP2) Dielectric measurements
   (KRP3) Stefan’s constant; High resistance by leakage
   (KRP4) Thermal diffusivity
   (KRP5) Temperature dependence of capacitance

4. Dr. S.B. Gudennavar
   (SBG1) AC Experiments
   (SBG2) Passive Filters
   (SBG3) Thermal Relaxation of a bulb

5. Prof. R. Srinivasan
   (RS1) Lock in amplifier
   (RS2) Measurement of mutual inductance
   (RS3) Errors and their analysis

6. Spl. Lectures
   (CSR) To be delivered by faculty of Alagappa University on their research
   (School of Physics, Alagappa University)
   (MJ) Facilities available for research
   (SM) Nano science and technology for energy conversion
   (SM) Corrosion diagnosis, control methods and sensors for corrosion monitoring applications

7. Discussion sessions
   Participants to seek clarifications
Names of Resource Persons

1. Prof. R. Srinivasan
   Chairman, Refresher Course in Experimental Physics
   Former Director, UGC-DAE CSR, Indore

2. Prof. S. M. Sadique (Rtd)
   Department of Physics, Goa University
   Taleigao Plateau, Goa 403 206 India

3. Dr. Kaustubh R. S. Priolkar
   Department of Physics, Goa University
   Taleigao Plateau, Goa 403 206 India

4. Dr. Efrem D'Sa,
   Department of Physics, Goa University
   Taleigao Plateau, Goa 403 206 India

5. Dr. S. B. Gudennavar,
   Christ University, Bangalore

Names of Speakers

1. Prof. C. Sanjeeviraja
   Chairperson and Head
   School of Physics
   Alagappa University
   Karaikudi-630 003

2. Dr. M. Jayachandran
   Deputy Director and Head
   ECMS Division
   Central Electrochemical Research Institute
   Karaikudi-630 006

3. Dr. S. Muralidaran
   Senior Scientist
   Corrosion Division
   Central Electrochemical Research Institute
   Karaikudi-630 006