

## TCIS, Hyderabad

**Course: Research Methodology**

**Start Date:** 2 August 2017

**Coordinates (Preferred):** Monday and Wednesday between 02.00 pm and 03.30 pm

**Instructor(s):** Subodh R. Shenoy; Aprotim Mazumdar and Prasad Perlekar

### **Syllabus:**

*Credits:* 4-credit full-semester course.

*Duration:* 2 lectures of 1.5 hrs/week for 14 weeks → 28 lectures = 42 hrs.

Scientific research involves a mature understanding of past literature, providing contextual motivation for current work; a judicious analysis of generated data; good presentational skills; and an appreciation of the foundational role of scientific ethics and scientific method. The course will cover diverse areas such as research ethics, literature survey, quantitative methods of data and statistical analysis with practical applications to real- world data, and field visits. Because of the universal need for these research methods, values and skillings, this course is mandatory for graduate students of all the three subject-boards relevant to TIFR Hyderabad (Physics, Chemistry and Biology). The course includes topics below. (Square brackets show [No. of classes]. Smaller font is (informal teacher's notes on the topics to be covered)).

### **1.SKILLING STUDENTS TO:**

\* Sketch a Function [2]

(Function *and* slope. Symmetries, Special pts, asymptotes, draw segments. Join up!)

\* Write a CV [1]

(First impression. Show professionalism! CV content. Fonts, topics, and sequencing.)

\* Write a Letter [1]

(Apply for postdoc. Ask to visit. Request to be cited.)

\* Talk about research work [1]

(10 minute talk, 1 minute talk, coffee conversation, the elevator pitch, 140-character tweet.)

\* Give a Research Talk [2]

(Judge audience! 1 slide ~ 2 mins. Intro/Motivation/Methods/Results/Takeaways. Questions.)

\* Write a Research Paper [2]

(Abstract, Text, Fig Caps, Refs, Acknowledgements. Proof-reading. Good/Bad writing examples.)

\* Read a Research Paper [1]

(Quick-read. Skim text, main refs. Go to Origins, trace Evolutions. Detailed reading.)

\* Make Quantitative Estimates [2]

(Memorize basic constants, sizes. Internal conversation. Compare others, on Log scale.)

## **2. METHOD OF SCIENCE [2]**

(Theoretical model, predict→Quantitative experimental test→Keep/ Modify model, predict→...Ideas of Bacon, Occam, Popper, Kuhn.)

## **3. RESEARCH ETHICS AND AVOIDING PLAGIARISM [2]**

(Dangers of copy-paste. Plagiarism. Proper citing. Indian Academy of Sciences Report)

## **4. VISUAL REPRESENTATION OF RESEARCH DATA [2]**

(Optimal design of plots, charts, schematics, posters etc for graphic display of empirical relationships in complex data.)

## **5. ERROR ANALYSIS OF RESEARCH DATA [3]**

(Random and systematic errors. Statistical errors and probability distributions. Error propagation or addition of errors.)

## **6. STUDENT PRESENTATIONS [6]**

(Research Literature. 25+5 min talks, 3 per class. Graded. Two cycles, if class-size permits.)

## **7. LAB VISITS [1]**

(Students split up for Bio/ Chem/ Phys tours, guided by Senior PhD students)

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### **Primary Text / Reference Books:**

1. *Scientific Writing and Communication*, Angelika Hofmann, (Oxford 2014).

2. *Back-of-the-Envelope Physics*, Clifford Swartz, (Johns Hopkins 2003).

3. *The Visual Display of Quantitative Information*, Edward Tufte (Graphics Press 1982); Bang Hong, *Nature Methods* articles.

4. *Measurements and their Uncertainties*, IG Hughes and TPA Hase, (Oxford 2014).

5. *Advice to a Young Scientist*, Peter B Medawar, (Basic Books 2008).

**Evaluation Method:** Based on student written hand-ins (50%) and student oral presentations (50%).

