



SECOND SEMESTER 2023-2024

Course Handout Part II

Date: 30-12-2023

In addition to Part-I (General Handout for all courses appended to the time table) this portion gives further specific details regarding the course.

Course No. : BITS G661
Course Title : Research Methodology I
Instructor-in-Charge : Karthik Chethan V.

1. Scope and Objective of the Course:

This course introduces the student to the scientific method of conducting research and will provide a practical framework on which a student can base his/her research. The objective of this course is to inculcate a systematic approach to research including formulating a research topic, testable hypothesis, designing experiments, collecting and analyzing data and presenting their research in the form of reports, articles, thesis and seminars. The course also introduces the student to various analytical instruments and equipment commonly used in research laboratories as well as tools for data analysis. As part of the course, students will work on projects in which they can integrate the concepts learnt in class.

Course Outcomes (CO):

CO1. To learn and gain some insights in real research related problem statements and its association in product innovation (familiarity with reactions, processes, problem solving, product development and characterization of materials that are commonly encountered in adhesive, composite, aerospace, defence, soap, food, chemical and biotechnology industries).

CO2. To conduct hypothesis based discussions to solve these statements and engineering based issues in a confident and feasible manner by combining conceptual, numerical and design based solutions learnt during the course of the semester. The issues can be product development, process, quality control and application related.

CO3. To inculcate the skill of coupling micro and macro aspects of research and development, and to apply interdisciplinary skills of science and engineering in problem-solving. The course will attempt to cover various case studies in research and development.

Student Learning Outcomes (SLO): SLOs are outcomes (a) through (k) plus any additional outcomes that may be articulated during the course.

(a) an ability to learnt to alleviate and manage fear (fear of failure, embarrassment, grades etc.) which rears its ugly head in learning and learn to connect and collaborate with peers and faculty in and out of classrooms. To develop into thinking (how and why) and collaborative individuals.

(b) an ability to apply knowledge of science and engineering.

(c) an ability to design and conduct characterization experiments, as well as to analyze and interpret results.

- (d) an ability to select and apply relevant characterization techniques to meet specific desired needs within realistic constraints such as availability, expertise and economics.
- (e) an ability to function on teams.
- (f) an ability to identify, formulate, and solve engineering problems.
- (g) an understanding of professional and ethical responsibility.
- (h) an ability to communicate effectively.
- (i) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
- (j) a recognition of the need for, and an ability to engage in life-long learning
- (k) a knowledge of contemporary issues
- (l) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

2. Textbooks:

1. C.George Thomas “Research Methodology and Scientific Writing”, Ane Books Pvt. Ltd., 2015.

Reference Books:

R1. Martin Goldstein and Inge F. Goldstein, HOW WE KNOW, An exploration of the scientific process, Da Capo Press; Revised ed. edition (22 March 1981) (Available in Amazon India, <https://www.amazon.in/How-We-Know-Martin-Goldstein/dp/030680140X>)

3. Course Plan:

| Lecture No. | Learning objectives | Topics to be covered | Chapter in the Text Book |
|-------------|---|---|--------------------------|
| 1-2 | Describe the elements of research and the scientific method | Need for academic research Introduction to the scientific method Research methodology and research methods | 1 |
| 3 | Identify the approaches to research Differentiate between types of research | Formal and informal approaches to research Basic versus applied research, Qualitative and Quantitative research, Experimental research, Variables in research | 3 |
| 4-11 | Formulate a hypothesis Design experiments using statistical tools Understand the significance of controls | Cause effect relationships, hypothesis, experiments, errors, use of controls, Statistical design of experiments, Taguchi methods Framing a hypothesis | 4, 5 |
| 12-20 | Collect relevant data Analyze data using statistical tests Represent data appropriately in tables, graphs, etc. | Data collection and record keeping Data analysis Statistics – commonly used tests, Grey relational analysis (GRA) Representing data – tables versus figures Illustrations, Types of graphs Use of tools such as MS Excel, Origin | 6, 11 |
| 21-24 | Carry out a thorough literature review and summarize | Importance of reviewing the literature Sources available Locating relevant literature Reliability of sources | 8, 12 |

| | | | |
|-------|--|--|-------------|
| | Identify and use tools to store and organize literature | Note making, Paraphrasing, Writing a review Citing literature | |
| 25-30 | Write a paper Describe the elements of a journal article, thesis Make clear and well defined presentations Present ideas, data and results in a forum | Scientific writing – grammar, writing styles, Writing research papers, review papers, thesis Selecting a journal Editing, formatting, Referencing Review and peer review, Proofreading Presentations, posters, How to present in seminars | 10, 13, 14 |
| 31 | Understand the ethical aspects of research | Ethics in research, Plagiarism Intellectual Property Rights Unscientific practices, Whistle blowing | 15 |
| 32-40 | Explain the principle involved in various analytical instruments and equipment | Demonstrations of equipment such as DSC, TGA, FTIR, Microscopes, spectrophotometer, chromatography systems, UTM, XRD, XRF, SEM and others. Analysis of data and images. | Lab manuals |

4. Evaluation Scheme:

| Component | Duration | Weightage | Date & Time | Remarks |
|-----------------------|----------|-----------|-------------|-----------|
| Midterm | 90 mins | 20% | | Open Book |
| Continual Evaluation* | NA | 45% | | Open Book |
| Comprehensive Exam. | 3 hours | 35 % | | Open book |

*Continual evaluation will involve the following:

1. Brainstorming and interacting in class (attending classes and maintaining continuity is highly encouraged). For the instructor it will allow for clear assessment of students and provide relevant opportunities for students to continually learn and improve.
2. Lab visits and learning in hands-on manner (attending labs and experimenting is highly encouraged).
3. Each student will work on a group project for the semester (the projects will be part of the project or activity based learning (experiential learning)) (the students will work on the project individually and the freedom to choose project problem statements will be provided to the students). More details about the projects will be discussed when we meet in class.
4. Last but not least, for a fair continual evaluation, attending classes and interacting in class and conducting project activities is imperative.
5. 45% of continual evaluation is split into the following: 20% is for project activity, 15% is for involvement and interaction in class, 5% is for industrial trip and other miscellaneous activities and 5% is for student's abilities of positive attitude, resilience, creativity and ability to learn.

Chamber Consultation Hour: To be announced later.

Notices: All notices related to the course will be uploaded in CMS.

Make-up Policy: Make-up will be granted for genuine cases with prior approval.

Academic Honesty and Integrity Policy: Academic honesty and integrity are to be maintained by all the students throughout the semester and no type of academic dishonesty is acceptable.

Karthik Chethan V.
INSTRUCTOR-IN-CHARGE