

CATALOG INFORMATION

Dept and Nbr: ENGR 67

Title: STEM RESEARCH PRINCIPLES

Full Title: STEM Research: Principles, Methods and Practices

Last Reviewed: 11/13/2023

Units		Course Hours per Week		Nbr of Weeks	Course Hours Total	
Maximum	2.00	Lecture Scheduled	2.00	17.5	Lecture Scheduled	35.00
Minimum	2.00	Lab Scheduled	0	12	Lab Scheduled	0
		Contact DHR	0		Contact DHR	0
		Contact Total	2.00		Contact Total	35.00
		Non-contact DHR	0		Non-contact DHR	0

Total Out of Class Hours: 70.00

Total Student Learning Hours: 105.00

Title 5 Category: AA Degree Applicable

Grading: Grade or P/NP

Repeatability: 00 - Two Repeats if Grade was D, F, NC, or NP

Also Listed As: ASTRON 67, BIO 67, CHEM 67, ERTHS 67, GEOG 67, GEOL 67, MATH 67, PI

Formerly:

Catalog Description:

In this course, students majoring in Science, Technology, Engineering, and Mathematics (STEM) will be introduced to scientific research principles needed to understand the skills required for careers that include elements of research practice. The course explores the scientific method, how research is defined, creation of knowledge, effective experiment design, and components that include principles of data recording, formulating and testing of hypotheses, communication of results, venues of dissemination, and the process of peer review.

Prerequisites/Corequisites:

Course Completion of BIO 10 OR CHEM 42 OR ENGR 10 OR MATH 25 OR MATH 58 OR MATH 27 or higher (MATH); or AB705 placement into Math Tier 4

Recommended Preparation:

Eligibility for ENGL 1A or equivalent

Limits on Enrollment:

Schedule of Classes Information:

Description: In this course, students majoring in Science, Technology, Engineering, and Mathematics (STEM) will be introduced to scientific research principles needed to understand the skills required for careers that include elements of research practice. The course explores the scientific method, how research is defined, creation of knowledge, effective experiment design, and components that include principles of data recording, formulating and testing of hypotheses, communication of results, venues of dissemination, and the process of peer review. (Grade or P/NP)

Prerequisites/Corequisites: Course Completion of BIO 10 OR CHEM 42 OR ENGR 10 OR MATH 25 OR MATH 58 OR MATH 27 or higher (MATH); or AB705 placement into [Math Tier 4](https://assessment.santarosa.edu/understanding-your-math-placement)

Recommended: Eligibility for ENGL 1A or equivalent

Limits on Enrollment:

Transfer Credit: CSU;

Repeatability: Two Repeats if Grade was D, F, NC, or NP

ARTICULATION, MAJOR, and CERTIFICATION INFORMATION:

AS Degree:	Area	Effective:	Inactive:
CSU GE:	Transfer Area	Effective:	Inactive:
IGETC:	Transfer Area	Effective:	Inactive:
CSU Transfer:	Transferable	Effective: Fall 2024	Inactive:
UC Transfer:		Effective:	Inactive:

CID:

Certificate/Major Applicable:

Not Certificate/Major Applicable

COURSE CONTENT

Student Learning Outcomes:

At the conclusion of this course, the student should be able to:

1. Identify career positions in STEM that include research practices
2. Describe the principles of research defined by the scientific method
3. Apply the principles of research to design experiments
4. List the elements involved in effective communication of research results

Objectives:

At the conclusion of this course, the student should be able to:

1. Differentiate among research components involved in academic, industrial, medical, and government careers
2. Identify the elements involved in the planning and conducting of experiments
3. Identify the elements involved in writing research proposals, formulating hypotheses, and recording, analyzing, and interpreting data
4. List the elements involved in effective writing of poster and oral presentations, and publishing of research results
5. Identify reliable sources of information and venues for networking and disseminating of

research results

Topics and Scope:

I. Defining STEM Research

- A. Historical background of the empirical methods
- B. Generating research ideas
- C. Setting criteria for worthwhile research topics
- D. Safety and ethical issues

II. Research Design

- A. Components of a STEM experimental research design
- B. Difference between quantitative and qualitative data

III. Preparing Background Information

- A. Writing background research questions
- B. Identifying credible scientific resources
- C. Methods of notetaking
- D. Avoiding plagiarism

IV. The Scientific Method: Writing Hypotheses

- A. Defining a scientific hypothesis
 - 1. The method of inductive reasoning based on observation
 - 2. The principle of skepticism
 - 3. The principle of testability
 - 4. The principle of falsifiability
 - 5. The principle of reproducibility
- B. Writing drafts of the hypothesis

V. Writing Research Proposals

- A. Generation of knowledge and the logic model
- B. Proposal components
- C. Elements of scientific writing

VI. Organizing a Laboratory Notebook

- A. Recording data
- B. Components of a laboratory notebook

VII. Descriptive Statistics

- A. Recording calculations in a laboratory notebook
- B. Introduction to descriptive statistics
- C. Using descriptive statistics to explain experimental results

VIII. Graphical Representations

- A. Graphing quantitative data
- B. Graphing qualitative data

IX. Analyzing and Interpreting Data

- A. Introduction to inferential statistical tests
- B. Data interpretation

X. Writing Research Articles for Publication

- A. Parts of STEM research articles
- B. Preparing articles for publication
- C. The process of publishing
 - 1. Credible venues for publishing
 - 2. The peer review process

XI. Disseminating Research Results

- A. Elements of poster presentations
- B. Elements of oral presentations
- C. Credible venues for research presentations

- D. Networking with the STEM community
- XII. Introduction to Career Positions with STEM Research Components, such as
- A. Research in academia
 - 1. Early research opportunities for undergraduate students
 - 2. Research in universities
 - 3. Research in academic institutes
 - B. Research and development in industries
 - 1. Research in technology companies
 - 2. Research in artificial intelligence, social networks, big data
 - 3. Research in macro and micro economies and markets
 - C. Research in medical fields
 - 1. Design of medical trials
 - 2. Testing of drug efficacies
 - D. Research in government
 - 1. Military research
 - 2. Research in national laboratories
 - E. Research in other STEM discipline positions

Assignment:

- 1. Weekly reading in text and other sources (5-10 pages)
- 2. Written and oral assignments (4-8), which may include:
 - A. Short essays summarizing reading comprehension
 - B. Analyzing example research articles
 - C. Writing a mock research proposal
 - D. Designing a mock experiment
 - E. Writing up an example research report, including analysis, graphing, and interpretation of data
 - F. Preparing an example poster and oral presentation
- 3. Outside activity(ies) (1-3), which may include:
 - A. Visit to an instructor-approved research facility (1)
 - B. Participation in a concurrent research project (independent study or part of a class)
 - C. Day shadowing an instructor-approved researcher (1)

Methods of Evaluation/Basis of Grade:

Writing: Assessment tools that demonstrate writing skills and/or require students to select, organize and explain ideas in writing.

Written assignments

Writing
50 - 75%

Problem Solving: Assessment tools, other than exams, that demonstrate competence in computational or non-computational problem solving skills.

None

Problem solving
0 - 0%

Skill Demonstrations: All skill-based and physical demonstrations used for assessment purposes including skill performance exams.

None

Skill Demonstrations
0 - 0%

Exams: All forms of formal testing, other than skill performance exams.

None

Exams
0 - 0%

Other: Includes any assessment tools that do not logically fit into the above categories.

Oral assignments; outside activity(ies)

Other Category
25 - 50%

Representative Textbooks and Materials:

STEM Student Research Handbook. Harland, Darci J. NSTA Press. 2011 (classic)
Instructor Prepared Materials