CSCI3001: GRAND CHALLENGES IN THE WORLD

Effective Term
Semester B 2022/23

Part I Course Overview

Course Title
Grand Challenges in the World

Subject Code
CSCI - College of Science
Course Number
3001

Academic Unit
College of Science (SI)

College/School
College of Science (SI)

Course Duration
One Semester

Credit Units
3

Level
B1, B2, B3, B4 - Bachelor's Degree

Medium of Instruction
English

Medium of Assessment
English

Prerequisites
Nil

Precursors
CSCI2002

Equivalent Courses
Nil

Exclusive Courses
Nil

Part II Course Details

Abstract

This experiential and integrated course, designed for Year 3 or Year 4 CSCI undergraduate students (Year 2 students with CGPA 3.00 or above will also be considered), aims to: (1) systematically guide students to integrate the content of different courses across the semesters into a coherent body of knowledge, and then (2) apply this body of knowledge to solve real-world problems, with an emphasis on leadership and teamwork training. Students will learn research methodologies and design thinking through case-studies of published papers, past proposals, competition entries or entrepreneurial ideas on real-world problems, before identifying their own research questions. They will then conduct a small research project in an attempt to provide scientific or technical solutions to these problems. Given the complex nature of real-world problems, students will be encouraged to build multi-disciplinary teams for these research projects. Using a student-centred pedagogy, this course combines project-based learning with course integration, interdisciplinary connections, teamwork and communication.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	DESCRIBE the key steps towards the generation of scientific knowledge. Through discussions and teamwork, REFLECT and CRITICAL EVALUATE these steps by case-studies of published papers, proposals, competition entries or entrepreneurial ideas.		x	x	
2	IDENTIFY a real-world problem and/or a state-of-the-art research problem related to the students' BSc programmes to which the students are expected to work in multi-disciplinary teams to contribute original and useful solutions within the duration of this course.		x		x
3	HYPOTHESISE potential solutions to the problem identified in (1).		x		x
4	DESCRIBE specific contents from at least three courses the students have previously taken during their BSc studies that are instrumental to the conception or execution of the idea formulated in (2).		x	x	x
5	Working in multi-disciplinary teams, DESIGN and PERFORM experiments which GENERATE original data to test the hypothesis formulated in (3).			x	x
6	PRACTICE the effective communication of the significance of the real-world problem and the proposed solution in both written and oral presentations.				x
7	REFLECT the impact of the work produced in this course on the real-world or research problem identified in (1) by assessing the validity of the hypothesis established in (3) and EVALUATE how the course contents described in (4) contributed to the impact.				x

A1: Attitude

Develop an attitude of discovery/innovation/creativity, as demonstrated by students possessing a strong sense of curiosity, asking questions actively, challenging assumptions or engaging in inquiry together with teachers.

A2: Ability
Develop the ability/skill needed to discover/innovate/create, as demonstrated by students possessing critical thinking skills to assess ideas, acquiring research skills, synthesizing knowledge across disciplines or applying academic knowledge to real-life problems.

A3: Accomplishments
Demonstrate accomplishment of discovery/innovation/creativity through producing /constructing creative works/new artefacts, effective solutions to real-life problems or new processes.

Teaching and Learning Activities (TLAs)

	TLAs	Brief Description	CILO No.	Hours/week (if applicable)
1	Online learning	Students will learn the key steps towards the generation of scientific knowledge, including the identification of scientific problems, generation of ideas, formulation of hypotheses, literature review and communication of scientific ideas and data, by going through a number of videoed lectures, websites and reading materials.	1	
2	In-class discussion	Students will use real-life examples found in publications, research proposals, competition entities or entrepreneurial ideas to validate the research methodology they learned in (1). Working in teams, they will then critically appraise these past examples, identifying their strengths and weaknesses, and suggest potential improvements.	1	
3	Group / Individual discussion	Identification of research questions through discussions with the supervisor. The students will work in teams to practice the methodology learned in (1) and (2) and develop hypotheses that will offer potential solutions to the problem.	1, 2, 3	

4	Undertaking of research and analysis of data	Undertaking of suitable research under supervision, and maintaining a good record of data collected in the process. Where necessary, data analysis, with the use of appropriate statistical techniques, will be conducted.	5	
5	Written and oral presentation	Writing, under supervision, a scientific report that summarises the results in (4). Delivery of a formal oral presentation of the research project followed by questions from the audience.	6	
6	Reflective writing	Each student will submit a piece of reflective writing that explains how the research is informed or inspired by the content of at least 3 courses taken previously in CityU. The reflection should contain explicit examples of how the knowledge acquired from each course has contributed to the research.	4, 7	

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks (e.g. Parameter for GenAI use)
1	Online reading and exercise	1, 2	5	
2	Class discussion	3, 4	15	
3	Research	6	50	
4	Oral and written presentation of research outcome	7	20	
5	Reflective writing	5	10	

Continuous Assessment (%)

100

Examination (%)

0

Additional Information for ATs
Students must achieve a minimum of 40% in order to pass the course.

Assessment Rubrics (AR)

Assessment Task
Online reading and exercise

Criterion
COMPLETE an online course on research methodology and FINISH all exercises.

Excellent (A+, A, A-)
100%

Good (B+, B, B-)
>80%

Fair (C+, C, C-)
>60%

Marginal (D)
>40%

Failure (F)
Did not complete

Assessment Task
In-class discussion

Criterion
ABILITY to IDENTIFY each component of research methodology in a given piece of past research. ABILITY to EVALUATE the strengths and weaknesses of the past research and OFFER suggestions on improvement.

Excellent (A+, A, A-)
High

Good (B+, B, B-)
Significant

Fair (C+, C, C-)
Moderate

Marginal (D)
Basic

Failure (F)
Not even reaching marginal levels

Assessment Task
Research

Criterion

ABILITY TO IDENTIFY important knowledge gaps and OFFER viable and original suggestions on potential solutions to the problem. ABILITY TO DESIGN methods that can test the suggested hypotheses, and to GENERATE reliable and reproducible data through the correct and accurate use of research methodology. SHOW EVIDENCE of diligently engaging in the research.

Excellent (A+, A, A-)

High

Good (B+, B, B-)

Significant

Fair (C+, C, C-)

Moderate

Marginal (D)

Basic

Failure (F)

Not even reaching marginal levels

Assessment Task

Oral and written presentation of research outcome

Criterion

ABILITY TO DEMONSTRATE an thorough understanding of the project topic and excellent execution of a wide range of conventions relevant to science, to logically illustrate mastery of the subject, to use existing references to support the ideas, to present and analyse data in excellent ways, to discuss the assumptions, limitations, and weaknesses, to present logical and excellent explanations for the findings and accurately address the hypothesis, and to use scientific languages that skillfully communicate meaning to readers with clarity and fluency.

Excellent (A+, A, A-)

High

Good (B+, B, B-)

Significant

Fair (C+, C, C-)

Moderate

Marginal (D)

Basic

Failure (F)

Not even reaching marginal levels

Assessment Task

Reflective writing

Criterion

ABILITY to explain how the research is related to the content of at least 3 courses taken previously in CityU. SHOW explicit examples of how the knowledge acquired from each course has contributed to the research.

Excellent (A+, A, A-)
High

Good (B+, B, B-)
Significant

Fair (C+, C, C-)
Moderate

Marginal (D)
Basic

Failure (F)
Not even reaching marginal levels

Part III Other Information

Keyword Syllabus

Week 1-2:

Each week, students will be given a number of videoed lectures, websites and reading materials on the key steps towards the generation of scientific knowledge, including the identification of scientific problems, generation of ideas, formulation of hypotheses, literature review and communication of scientific ideas and data. After completing these online readings, students conduct classroom discussions on real-life examples found in publications, research proposals, competition entities or entrepreneurial ideas. Through a number of brainstorming exercises, they will validate the research methodology they learned in the online materials. They will then critically appraise these past examples, identify their strengths and weaknesses, and suggest potential improvements.

Week 3-4:

The class will then split up into interdisciplinary teams according to the study programmes and/or research interests. Each team will be assigned to a mentor. Through discussion with their mentors, the students will identify their research problems and formulate possible solutions to the problems. Students are strongly encouraged to work in multi-disciplinary teams. Under exceptional circumstances and at the discretion of the Course Leader, however, a small number of students will be permitted to work individually given the nature or scope of the research problem chosen.

Week 5-13:

The students will conduct research under the supervision of the mentor. The outcome maybe an invention, a piece of academic research or a business proposal.

Each student will then submit a written report and deliver an oral presentation on (a) the data and discovery in this study, (b) how the research can be expanded or improved to cater for a real-world problem, and (c) how their solution is compared to the past entities of the competition they chose as a case study.

In additional, the students will compose a piece of reflective writing that explains how the research is informed or inspired by the content of at least 3 courses taken previously in CityU. The reflection should contain explicit examples of how the knowledge acquired from each course has contributed to the research.

Reading List

Compulsory Readings

	Title
1	Dawson, C. (2007). A practical guide to research methods: a user-friendly manual for mastering research techniques and projects (3rd ed.). Oxford: How To Books. Available as E-book in the CityU library.

2	Lindsay, D. (2011). Scientific Writing = Thinking in Words. Victoria: CSIRO Publishing. Available as E-book in the CityU library.
3	https://libguides.library.cityu.edu.hk/researchmethods

Additional Readings

	Title
1	Alon, Uri. "How to choose a good scientific problem." Molecular cell 35.6 (2009): 726-728. https://www.sciencedirect.com/science/article/pii/S1097276509006418?via%3Dihub
2	D. Schafersman: Scientific thinking and the scientific method. https://www.geo.sunysb.edu/esp/files/scientific-method.html
3	Alon, Uri. "How to give a good talk." Molecular cell 36.2 (2009): 165-167. https://www.sciencedirect.com/science/article/pii/S1097276509007424
4	Sinclair Goodlad, "Speaking Technically: A Handbook For Scientists, Engineers And Physicians On How To Improve Technical Presentations" (World Scientific 1996)
5	Yang, J T, "An Outline of Scientific Writing" (World Scientific, 160pp, 1995)
6	C. Ling & Q. Yang, "Crafting your Research Future" (Morgan & Claypool Publishers 2012)
7	Glasman-Deal H. Science Research Writing: For Native And Non-native Speakers Of English, 2nd ed.; World Scientific, 2020.
8	Goodwin, J.; Hanson, D.; Wolfskill, T. Solving Real Problems with Chemistry, 2nd ed.; Pacific Crest, 2011. http://pcrest.com/PC/books/srpwc2.html
9	Tsaparlis, G. Problems and Problem Solving in Chemistry Education: Analysing Data, Looking for Patterns and Making Deductions; Advances in Chemistry Education Series No. 7; Royal Society of Chemistry, 2021. doi: 10.1039/9781839163586
10	Adamo, F. S: Effective Presentations for Chemists and Other Scientists. https://www.labmanager.com/leadership-and-staffing/effective-presentations-for-chemists-and-other-scientists-21084
11	A first course in mathematical modelling, by Frank R. Giordano, William P. Fox and Steven B. Horton, Cengage Learning, 2013.
12	Introduction to Probability Models, by Sheldon M. Ross, Tenth edition, Academic Press, 2010.
13	Mathematics applied to deterministic problems in the natural sciences, by C. C. Lin and L. A. Segel, Second edition, Society for Industrial and Applied Mathematics (SIAM), Philadelphia, PA, 1988.
14	Practical applied mathematics. modelling, analysis, approximation, by S. D. Howison, Cambridge Texts in Applied Mathematics, Cambridge University Press, Cambridge, 2005.
15	Mathematical models in the applied sciences, by A. C. Fowler, Cambridge Texts in Applied Mathematics. Cambridge University Press, Cambridge, 1997.