Subject Description Form

Please read the notes at the end of the table carefully before completing the form.

Subject Code	AMA1D06W
Subject Title	Great Scientific Achievements that Changed the World - Explained with Applications
Credit Value	3
Level	1
Pre-requisite / Co-requisite/ Exclusion	nil
Objectives	The subject aims to explore the most important and influential scientific discoveries that changed the world, in layman terms, i.e., in the simplest, brief, clear, intuitive, and suitably leveled terms. The student will gain an understanding and appreciation of the scientific discoveries (and the history behind it) and its multitude of applications for the betterment of the human condition currently, and in the future.
Intended Learning Outcomes *(Note 1)*	Upon completion of the subject, students will be able to: (a) Understand the history and motivation of the theory and the basic postulates of each scientific theory. (b) Recognize and appreciate the importance of the scientific theories to solving real world problems. (c) Explain and value the significance of the intellectual achievements and how they have changed humanity's view of the world. (d) Summarize the overall message of scientific articles published in popular media (magazines, newspapers, websites) and references (journals and books) about recent developments in science
Subject Synopsis/ Indicative Syllabus *(Note 2)*	<u>Geometry and Calculus</u> History of Geometry; Basic postulates of Euclidean Geometry; Pythagoras; non-Euclidean Geometry; applications to real life such as architecture; medicine (MRIs and molecular imaging); animation and movies. History of Calculus; Newton and Leibniz; basic ideas of Calculus as a study of change, described with pictures and real life examples with applicable and relevant calculations; infinitesimal change; description of some applications of Calculus include landing a man on the moon; curing diseases; modeling financial markets; predicting weather and earthquakes. <u>Darwin's theory of evolution</u> History of Darwin's theory of evolution; living organisms and evolution; natural selection and survival; application to how genes, diseases and viruses change overtime and how to fight them using vaccines and drug development; generalized applications includes the study of development of education, literature and religion.

	Relativity Theory History of relativity; basic postulates of Einstein's theory of special relativity will be explained in layman terms with many pictures and examples: inertial frames; constancy of speed of light; general relativity; gravity; fourth dimension; consequences of the theory of relativity in science and philosophy; Einstein's famous $E=mc^2$ equation explained; applications to nuclear fusion and global positioning systems (GPS); black holes. Quantum Mechanics History of Quantum Mechanics; basic postulates of quantum mechanics in layman terms; differences between Newtonian and Quantum Mechanics; consequences of postulates of Quantum Mechanics in science, philosophy and religion: double split experiment and wave-particle duality, integer multiple energies and photons; probabilistic interpretations; Schrodinger's cat paradox; Heisenberg's uncertainty principle; applications of quantum mechanics: ultra-precise clocks; magnetic resonance imaging (MRI); cryptography; powerful computers; lasers and telecommunications. Other possible topics to be explored within a semester, depending on overall student interest (which will be assessed by a student survey taken at the beginning of class) are: Freudian and Pavlovian psychology; Heliocentrism, Combustion, Vaccines, DNA, Plate techtonics, statistical mechanics, Cosmology and Big Bang Theory; dark matter, elementary particles; Information Theory; Quantum computing; artificial intelligence; Game theory, Financial derivatives and the financial market. Review of topics will be done in consultation with various colleagues and departments and faculties at PolyU, e.g. AP, ABCT in FAST, FHSS, FE, FH, FB.
Teaching/Learning Methodology *(Note 3)*	The subject will be delivered with blended learning approach through lectures and tutorials with active learning components to heighten student engagement in both lecture and tutorials. Lectures and tutorials will contain student response systems incorporated with peer instruction to increase students' learning experience. E-material and videos will be made available for each topic covered. Videos will also be used to flip one or two lectures in the course. In class lecture active learning and participation will be promoted to increase interaction between students and instructions, and students with other students. In class participation will include raising questions or comments, and submitting online responses to multiple choice or short answer questions posed by the instructor during lecture. Questions, comments and online responses are recorded by student response systems (e.g.,YoTeach! Kahoot! Badaboom! PaGamO) Tutorials will include interactive and student-centered activities, such as small group discussions, student demonstrations, games, case-based and problem-based learning, think-pair-share and online research on certain scientific theories discussed in lectures. Tutorials will also incorporate problems similar to the reading quiz and will prepare students for this assessment. The last two to three tutorials of the semester will be allocated for student presentations on

their selected written projects.

Tentative Teaching and Learning Schedule:

Weeks 1: Introduction to Geometry.
Week 2: Applications of Geometry to real life.
Week 3: Calculus for the Layman.
Week 4: Applications Calculus to real life.
Weeks 5: Darwin's theory of evolution; natural selection. *(Draft 1: 700 words to ELC due)*
Week 6: Applications of Evolutionary theory I: genes, diseases and viruses.
Week 7: Applications of Evolutionary theory II: education, literature and religion.
Weeks 8: Introduction to Relativity Theory. (Midterm Test)
Week 9: Introduction to General Relativity Theory.
Week 10: Applications of Relativity theory to real life. *Mechanics (Draft 2: 1500 words to ELC due)*
Weeks 11: Introduction to Quantum Mechanics *(30 minute Reading Quiz in tutorials)*
Week 12: Experiments and Interpretations of Quantum. *(Student Presentations in Tutorials)*
Week 13: Applications of Quantum Mechanics to real life. *(Student Presentations in tutorials)*
Week 13 (or later): *2500 word Final Paper due to Subject teacher*.

Assessment Methods in Alignment with Intended Learning Outcomes

(Note 4)

Specific assessment methods/tasks	% weighting	Intended subject learning outcomes to be assessed (Please tick as appropriate)					
		a	b	c	d		
1. Written project (English Writing Requirement) Draft 1700 words to ELC (Week 4 or 5) Draft 2 1500 words to ELC (Week 9 or 10) Final Paper 2500 words to Subject Teacher (Week 13 or later)	40 (30% + 10% from ELC)	✓	✓	✓	✓		
2. Midterm Test	15	✓	✓	✓	✓		
3. Presentation	15	✓	✓	✓	✓		
4. Reading Assessment/Quiz (English Reading Requirement)	10	✓	✓	✓	✓		

5. Final Exam	20	✓	✓	✓	✓		
Total	100 %						

Explanation of the appropriateness of the assessment methods in assessing the intended learning outcomes:

Written project: Students may select a scientific theory that has not been covered in class, and write a 2500 word review essay which covers the following topics: (a) what motivated the theory to come into being; (b) the basic postulates of the theory; (c) what are the important applications of this theory; (d) how do these applications solve some real world problems today, and (e) a brief description of a current topic which is unsolved in the theory today, that will help advance the theory and its applications to more problems in the future. A rubrics based on parts (a) to (e) will be employed to assign a grade to this project. Turnitin will be used to assess plagiarism. Possible project topics may include: Freudian and Pavlovian psychology; Heliocentrism, Combustion, Vaccines, DNA, Plate tectonics, statistical mechanics, Big Bang Theory; dark matter, elementary particles; artificial intelligence; Information Theory. Quantum computing; Game theory, financial derivatives and the financial market. The instructor must approve other topics not included in this list above. Topics must be chosen by students or approved by instructors by week 5 of the semester. Topics to be chosen by a student must not be in the student's major field of study.

Midterm Test: A one hour in class midterm-test will contain true/false and multiple choice questions, short answer questions, and possibly one or two long answer questions (one paragraph long) on the Geometry and Calculus and Darwin's theory of evolution, its consequences and its applications.

To complete this essay, students will submit two drafts online to ELC's EWR Learn@PolyU course site as part of the English Writing Requirement and receive detailed feedback from them to revise their drafts. The 1st and 2nd draft will be 700 and 1500 words, and be due in approximately the 5th and 10th week of classes, respectively. Students can also book up to two consultations with ELC teachers to discuss their writing. Final draft will be submitted to the Subject course site before the final examination date.

Excellent papers will be referred to Inscribe (peer-reviewed student journal) for publication.

Presentation: The presentation will be a maximum of four minutes in length on the topic chosen in their written project; and can be either a straight power point talk, or can be a "half" PechaKucha presentation (10 slides are shown 20 seconds each – with total length of 3 minutes and 20 seconds) on their chosen topic. PechaKucha slides must have minimal amount of writing, and have images, which represent the spoken presentation. Presentation grades will be allocated according to a rubric based on the following elements: organization, content, performance and originality. All student presentations will be peer (15%) and instructor (85%) reviewed and we will use the PolyU "Gongyeh" app for comments, feedback and assessment on each student presentation. Student presentations will be held in the last two weeks of tutorials of the semester.

Reading Assessment (English reading Requirement)

	Students are required to read 200,000 word book (or a maximum of 4 manuscripts) out of class and they will be assessed by a reading quiz, worth 10%. ***Reading Quiz (10%):*** Students will be given a reading assignment of two to three chapters in one of the books in the reference below, and be required to write a 30 minute quiz in the 11th week of tutorials. The quiz will consist of multiple-choice, fill in the blank, some short answer and one long answer question. **Final Exam**: The final exam will contain true/false, multiple choice and short answer questions, and possibly one or two long questions will be given to students in order to test their knowledge on the basics of a scientific theory, its consequences and its applications.	
Student Study Effort Expected	Class contact:	
	▪ Lecture	26 Hrs.
	▪ Tutorial	13 Hrs.
	Other student study effort:	
	▪ Homework and self-study	38 Hrs.
	▪ Research and preparation of written project and presentation	35 Hrs.
	Total student study effort	112 Hrs.
Reading List and References	Sections or chapters will be taken from the following books for the following topics: ***Geometry and Calculus*** Kalid Azad, "Calculus, Better Explained: A Guide To Developing Lasting Intuition", eBook + Video Course by Kalid Azad (see link https://betterexplained.com/calculus/) ***Darwin's theory of evolution*** Charles Darwin, "On the Origin of Species", Cambridge University Press, 2009 (electronic version) Richard Dawkins, "The Selfish Gene", Oxford University Press, 4th edition, 2016. Daniel Duzdevich, "Darwin's On the Origin of Species: A Modern Rendition", Indiana Press, 2014 ***Relativity theory:*** Martin Gardner, Relativity theory simply explained, Dover, 1997. Carlos I. Calle, "Einstein for Dummies", Wiley Publishing Inc., 2005 Kip S. Thorne, "Black Holes & Time Warps: Einstein's Outrageous Legacy", W.W. Norton & Company, 1994. ***Quantum Mechanics:*** Steven Holzner, "Quantum Physics For Dummies", Revised Edition, Wiley 2013	

	Leon M. Lederman, Christopher T. Hill, "Quantum Physics for Poets", Prometheus Books, 2011 A plethora of websites and e-materials pdfs, videos, etc…) to be listed in more detail in "Reference list" to be provided to students in the first day of class. ***Other Popular Science books for Reading Requirement*** Carl Sagan, "Cosmos", Random House, 1980. Fritjof Capra, "The Tao of Physics", Shambhala Publications, 1975. Stephen Hawking, "A Brief History of Time: From The Big Bang to Black Holes", Bantam Dell Publishing Group, 1988. Richard Feynman, "Surely You're Joking, Mr. Feynman!", W.W Norton, 1985. John A. Paulos, "Innumeracy: Mathematical Illiteracy and Its Consequences", Hill and Wang, 1988.

Note 1: Intended Learning Outcomes
Intended learning outcomes should state what students should be able to do or attain upon completion of the subject. Subject outcomes are expected to contribute to the attainment of the overall programme outcomes.

Note 2: Subject Synopsis/ Indicative Syllabus
The syllabus should adequately address the intended learning outcomes. At the same time over-crowding of the syllabus should be avoided.

Note 3: Teaching/Learning Methodology
This section should include a brief description of the teaching and learning methods to be employed to facilitate learning, and a justification of how the methods are aligned with the intended learning outcomes of the subject.

Note 4: Assessment Method
This section should include the assessment method(s) to be used and its relative weighting, and indicate which of the subject intended learning outcomes that each method purports to assess. It should also provide a brief explanation of the appropriateness of the assessment methods in assessing the intended learning outcomes.