Subject Description Form

Subject Code	AMA1D01C
Subject Title	The History of Ancient Chinese and World Mathematics
Credit Value	3
Level	1
Planned Student Intake per Year	Optimal class size: 75 Planned number of sessions to be offered: Semester 1: _____ Semester 2: 1 Summer Term: _____
GUR Requirements Intended to Fulfil	Please indicate which of the following GUR requirements the proposed subject intends to fulfil [Please check ALL boxes that may apply.] ☐ **Languages and Communication Requirement** (LCR) ☐ **Requirement in Healthy Lifestyle** ☐ **Broad Discipline Requirement** (BDR) Please specify Broad Discipline Area: _____ ☒ **Cluster Area Requirement** (CAR) Please check the box(es) below to indicate the cluster area(s) the subject contributes in a major way: ☐ Human Nature, Relations and Development ☐ Community, Organization and Globalization ☐ History, Cultures and World Views ☒ Science, Technology and Environment ☒ **China-Study Requirement** (CSR) More than 60% CSR-related content? Yes ☒ or No ☐ (Please check as appropriate) ☐ **Eligible for "English Writing" (EW) designation** - include an extensive piece of writing (2,500 words)? Yes ☐ or No ☐ (Please check as appropriate) ☒ **Eligible for "Chinese Writing" (CW) designation** - include an extensive piece of writing (3,000 characters) Yes ☒ or No ☐ (Please check as appropriate) ☐ **Eligible for "English Reading" (ER) designation** - include a reading of an extensive text (100,000 words or 200 pages)? Yes ☐ or No ☐ (Please check as appropriate) ☒ **Eligible for "Chinese Reading" (CR) designation** - include a reading of an extensive text (100,000 characters or 200 pages) Yes ☒ or No ☐ (Please check as appropriate)
Medium of Instruction	Please check the appropriate box: ☒ English ☒ Cantonese* ☐ Putonghua* ☐ Others* (Please specify: _____) **Justification(s):** For the part on Ancient Chinese History of mathematics, teaching materials would include those written in Chinese, and thus, the medium of instruction would include Cantonese. However, for the part of western-world History of Mathematics, English would be the major medium of instruction. * *In line with the University policy, English will be the medium of instruction except for the Chinese culture- or Chinese literature-related subjects, which will normally be taught in Putonghua as recommended by the Working Group. For other subjects to be offered in Cantonese, Putonghua or other languages, justifications should be provided for special consideration.*

Student Study Effort Required	Class contact:	
	▪ AMA Lecture	26 Hrs.
	▪ AMA Tutorial	13 Hrs.
	▪ CBS Lecture/Tutorial	TBA Hrs.
	Total class contact	45 Hrs.
	Other student study effort:	
	▪ Self Study	16 Hrs.
	▪ Assignments	8 Hrs.
	▪ Project (including drafting for CW requirement)	34 Hrs.
	▪ Preparation for quizzes (for CR requirement)	20 Hrs.
	Total student study effort	117 Hrs.
Pre-requisite and/or Exclusion(s) *(Note 2)*	Nil	
Objectives *(Note 3)*	(a) To introduce the historical development of mathematics of Ancient China and the world, and to expand students' intellectual capacity beyond their disciplinary domain so as to enable them to tackle professional and global challenges from a multidisciplinary perspective, and in a holistic manner. (b) To let students gain an enhanced understanding of China through ancient Chinese mathematics (CSR). (c) To nurture student's overall cultural appreciation via the learning of ancient worlds' mathematics. (d) To enhance student's Chinese Writing (CW) skills through Project writings and Assignments, and through instructional activities conducted by CBS staff. (e) To cultivate student's Chinese Reading (CR) skills so that they can demonstrate their understandings of the selected articles on Ancient Chinese Mathematics.	
Intended Learning Outcomes *(Note 4)*	Upon completion of the subject, students will be able to: (a) relate popular mathematical theories and results to their historical roots, and to comprehend popular Chinese literature of ancient Chinese mathematics (CR). (Relating mathematical theories to their historical roots would involve higher order thinking, whereas, to comprehend literature on ancient Chinese mathematics would involve literacy). (b) identify the achievements made by ancient Chinese as well as by other cultures in mathematics, and able to write about it (CR+CW). (To write about ancient Chinese mathematics would involve literacy, whereas, to be able to identify the achievement of mathematics of ancient Chinese and of other cultures would enhance students' interests, attitude, skills and intellectual capacity beyond their disciplinary domain to prepare for life-long learning). (c) apply simple ancient mathematical techniques to solve for ancient mathematical problems. (To be able to apply any mathematical techniques involve higher order thinking). (d) determine time line of events for the development of mathematics in ancient	

	China and other ancient cultures. (To be able to determine time line of events would enhance students' interests, attitude, skills and intellectual capacity beyond their disciplinary domain to prepare for life-long learning). (e) identify some famous mathematicians and give a brief account their major contributions in history of mathematics (CW). (To be able to give a brief historical accounts of ancient mathematicians would involve literacy, whereas, to be able to identify famous mathematicians would enhance students' interests, attitude, skills and intellectual capacity beyond their disciplinary domain to prepare for life-long learning).
Subject Synopsis/ Indicative Syllabus *(Note 5)*	中國古代數學 介紹先秦至清代中國數學發展、數學技巧及傑出數學家。比對中國古代與世界各地的數學發展歷程。題目包括： 1 概論 2 開方術 3 海島算經（唐代初年） 4 中國剩餘定理 5 測圓海鏡（金代） **Development of Mathematics outside China** We study and compare mathematics in different civilizations in different historical periods. Ancient Time Brief introduction to mathematics in ancient Egypt, Mesopotamia, Greece, India, and the Islamic world Modern Time Mathematics in Medieval and Renaissance Europe; The introduction of algebra; Pre-calculus and calculus in the 17th Century; Development of analysis, probability and statistics, algebra and number theory, and geometry in the 18th Century.
Teaching/Learning Methodology *(Note 6)*	Teaching of the subject is mainly through a traditional Lecture/Tutorial manner. Projects will be used to assess Writing requirement (CW) and quizzes will be used to asses Reading requirement (CR). Individual assignments and projects will be assigned to students. For the projects, students are required to write at least 3000 characters of Chinese (CW). AMA is responsible for the mathematics materials, whereas, CBS is responsible for the Chinese writing skills (CW). Four sets (of no less than 50 pages each) of additional materials written in Chinese will be assigned to students as reading materials (CR). Quizzes in the form of multiple choice questions will be conducted via the CBS system to test students on their understandings of the materials. Presentations will be given by the students during tutorials followed by in-class and small group discussions, and reports will be submitted afterwards. Students would

have to research for literature review, making use of our library and the internet extensively to source historical materials not presented in lectures and tutorials.

Topics on Projects could be, but not limited to the followings:
1. 談古今中外如何估算圓周率π。
2. 論李善蘭的尖錐求積術。
3. 論中國古代高次方程的數值解法。
4.中國古代如何應用重差術解決有關測量的問題。

Assessment Method

(Note 7)

Specific assessment methods/tasks	% weighting	Intended subject learning outcomes to be assessed (Please tick as appropriate)				
		a	b	c	d	e
1. Assignments	10%	✓	✓	✓		✓
2. Quizzes (to assess CR requirement)	20%	✓	✓			✓
3. Project/Presentation (to assess CW requirement)						
Marked by CBS	10%	✓	✓			
Marked by AMA	40%			✓	✓	✓
4. Exam	20%	✓	✓		✓	✓
Total	100 %					

Continuous Assessment comprises of assignments, project/presentation and quizzes. A written exam (predominately with multiple choice questions) is held at the end of the semester.

To pass the subject, students are required to obtain Grade D or above in both the Continuous Assessment and the Examination components in order to satisfy all the intended learning outcomes.

Reading List and Reference

Please indicate clearly in this section if the subject should have an "R" designation. If so, subject proposers should also indicate clearly which items on the Reading List constitute the expected reading requirement and include the page numbers.

"R" designation reading list:

(1) 吳文俊、白尚恕、沈康身，《劉徽研究》，九章出版社，1993。
pp. 79-86, 87-103, 104-121, 385-394, 402-413. (total 65 pages)

(2) 郭金彬、孔國平，《中國傳統數學思想史》，科學出版社，2004。
pp. 284-336. (total 53 pages)

(3) 紀志剛，《南北朝隋唐數學》，河北科學技術出版社，1999。
pp. 1-44, 356-386. (total 75 pages)

(4) 孔國平，《李冶朱世傑與金元數學》，河北科學技術出版社，1999。
pp. 36-80, 291-311. (total 66 pages)

Total number of pages for "R" designation reading list : 259 pages.

Textbook

- 錢寶琮，《中國數學史》，科學出版社，1981。

References

- 李儼、杜石然，《中國數學》，1986。
- Li Yan, Du Shiran, John N. Crossley, Anthony W.C. Lun, 《Chinese Mathematics A

	Concise History》, Oxford Science Publications, 1987. • 李迪，《中國數學史簡編》，遼寧人民出版社，1984。 • Victor J. Katz, 《A History of Mathematics》, 2004.

Subject Description Form

Subject Code	AMA1D03
Subject Title	Introduction to Pension Mathematics
Credit Value	3
Level	1
Pre-requisite / Co-requisite/ Exclusion	Nil
Objectives	(a) To introduce the concept of pension system, and to appreciate the role and the relationship of pension system to the society. (b) To let students gain an enhanced understanding of interest, discount, life contingency, and financial planning. (c) To nurture student's overall financial planning for retirement via the learning of pension mathematics.
Intended Learning Outcomes	Upon completion of the subject, students will be able to: (a) understand the importance of the pension system to our community. (b) evaluate the elementary measures of interest. (c) command the ideas of basic annuities payments and outstanding balance under amortization. (d) master the concept of measuring death and survival rates through life table. (e) analyze the key factors of the valuation of pension funds. (f) evaluate the normal cost and accrual liability for pension funds under various funding methods.
Subject Synopsis/ Indicative Syllabus	<u>Basic Mathematics</u> Experiment, data collection and analysis, elementary concepts of probability and statistical modeling in pension mathematics, model interpretation and validation. <u>Introduction to Pension Plans</u> Basic principle of pension schemes, importance of the pension schemes, defined benefit vs. defined contribution pension funds, stakeholders, normal cost, accrual actuarial liability, supplementary cost. <u>Measurement of Interest</u> Compound interest, nominal and effective interest and discount rates, present values of annuities, accumulated values of annuities, annuities with monthly payments. <u>Amortization Schedules</u> Outstanding balance, prospective method, retrospective method. <u>Survival Distributions and Life Tables</u> Age-at-death random variables, survival function, life tables, parametric and non-parametric survival/loss models, introduction to Cox proportional hazard

<table>
<tr><td></td><td>model.

<u>Life Annuities and Benefit Reserves</u>
Life annuities with monthly payments, benefit reserves.

<u>Pension Funding Valuation Methods</u>
Unit credit method, projected unit credit, entry age normal method, aggregate method, unfunded liability.</td></tr>
<tr><td>Teaching/Learning Methodology</td><td>Lectures:
Lectures will be conducted to present the basic principles and fundamentals of pension funding and the use of mathematics for in-depth understanding.

Tutorials:
Tutorial questions and Case study/presentation on the selected topics via reading and writing tasks will be employed to raise student’s interest and discussion by problem-solving approach.</td></tr>
<tr><td>Assessment Methods in Alignment with Intended Learning Outcomes</td><td>
<table>
<tr><td rowspan="2">Specific assessment methods/tasks</td><td rowspan="2">% weighting</td><td colspan="6">Intended subject learning outcomes to be assessed (Please tick as appropriate)</td></tr>
<tr><td>a</td><td>b</td><td>c</td><td>d</td><td>e</td><td>f</td></tr>
<tr><td>1.Assignments</td><td>30%</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td></tr>
<tr><td>2. Case study / Presentation</td><td>30%</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td></tr>
<tr><td>3. Test</td><td>10%</td><td></td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td></tr>
<tr><td>4. Exam</td><td>30%</td><td></td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td></tr>
<tr><td>Total</td><td>100 %</td><td colspan="6"></td></tr>
</table>

Continuous assessment (70%) comprises of assignments, Case study/ presentation, and test. Test (10%) will focus on the study of the science and techniques related to the mathematics of pension. Assignments (30%) also include the statistical method to build up survival model and to design Pension scheme with scientific methods and techniques. Besides, Case study/ presentations (30%) require students to read and search literature for the relevant topics about pension around the world and its development. A written examination (30%) will be held at the end of the semester.

To pass the subject, students are required to obtain Grade D or above in both the continuous assessment and the examination components in order to satisfy all the intended learning outcomes.

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

Assignment and test assess the students’ understanding of the basic concept and principle of the evaluation. Two assignments and one test will be given.

Case study/Presentation assess students’ problem solving, critical thinking, analytical and creative thinking skills. It will be based on their individual</td></tr>
</table>

	performance in presentation skills. The subjects focus on the integration of basic concepts and application of the evaluation techniques in pension mathematics. The assessment method based on **examination** is appropriate.	
Student Study Effort Expected	Class contact:	
	▪ Lecture	26 Hrs.
	▪ Tutorials	13 Hrs.
	Other student study effort:	
	▪ Self-study	39 Hrs.
	▪ Preparation for project & presentation	30 Hrs.
	Total student study effort	108 Hrs.
Reading List and References	<u>References:</u> 1. Atitken, W. H., A Problem-solving Approach to Pension Fund and Valuation, ACTEX Publication, 1996. 2. Kellison, S.G., The Theory of Interest (3rd ed.), McGraw-Hill/Irwin, 2009. 3. Bowers, N.L., Gerber, H.U., Hickman, J.C., Jones, D.A., and Nesbitt, C.J., Actuarial Mathematics (2nd ed.), Societies of Actuaries, 1997. 4. McGill, D, Brown, K.N., Haley, J.J., Schieber, S., and Warshawsky, M.J., Fundamentals of Private Pensions (9th ed.), New York: Oxford University Press, 2010. 5. Blake, D., Pension Schemes and Pension Funds in the United Kingdom (2nd ed.), New York: Oxford University Press, 2003. 6. Carmichael, I., Pension Power: Unions, Pension funds, and Social Investment in Canada, Buffalo: University of Toronto Press, 2005. <u>Reading List:</u> 1. Polzer K., Financing Future LTSS and Long Life Through more Flexible 401(k) and IRAs, 2014. (https://www.soa.org/Library/Monographs/Retirement-Systems/managing-impact-ltc/2014/mono-2014-managing-ltc.pdf) 2. Bikker, J.A., Steenbeek, O.W., and Torracchi F., The Impact of Scale, Complexity, and Service Quality on the Administrative Costs of Pension Funds: A Cross-country Comparison, Journal of Risk and Insurance, 79(2), 477-514, 2012. 3. Yang, Y., and Chen, K., Comparison of the Pension System Reform in East Asia and South-east Asia, Academics in China, 7, 269-273, 2015. 4. Comprix, J., and Muller, K.A., Pension Plan Accounting Estimates and The Freezing of Defined Benefit Pension Plans, Journal of Accounting and Economics, 51(1-2), 115-133, 2011.	

Subject Description Form

Subject Code	AMA1D04
Subject Title	Understanding Social Conflicts by Game Theory
Credit Value	3
Level	1
Pre-requisite / Co-requisite/ Exclusion	nil
Objectives	This subject aims to introduce basic concepts of game theory and related quantitative methods, which can be applied to analyze social issues and political situations, make reasonable social choice, evaluate optimal strategies to achieve equilibrium, and divide assets or costs fairly. Students will acquire quantitative skills required to analyze political, economic and social issues rationally, though a strong Mathematics background is not necessary.
Intended Learning Outcomes	Upon completion of the subject, students will be able to: (a) Understand voting systems in making social choice. (b) Evaluate political power of a body within a council by using simple models based on number of members and votes needed to pass a law. (c) Describe competitive situation between two bodies and analyze strategies. (d) Solve disputes among bodies by making a fair division or apportionment using quantitative methods. (e) Develop logical thinking and ability to explain issues or conflicts in society.
Subject Synopsis/ Indicative Syllabus	<u>Social Choice and Voting Systems</u> Introduction to social choice procedures and the properties they satisfy. These procedures include: Condorcet's method, plurality voting, Borda count, Hare system, approval voting. Examples will be given of voting systems in Hong Kong and all over the world. <u>Political Power</u> Evaluation of ways of forming a coalition among bodies in a council, evaluation of their political power by Shapley-Shubik index of power, Banzhaf index of power. Introduction of the chair's paradox. <u>Game Theory</u> Using two persons zero sum game and general sum game to understand concepts of dominant strategy, threat, Nash equilibrium, maxi-min strategy, mixed strategy, prisoner's dilemma. <u>Division and Auction</u> Problem of apportionment and Hamilton's method. Fair division using divide-and-choice method, adjusted winner procedure. Division of

<table>
<tr><td></td><td>contested sum in debt collection problem, taxi fare problem. Game tree analysis and the dollar auction problem. Examples of auction methods.</td></tr>
<tr><td>Teaching/Learning Methodology</td><td><u>Lectures:</u>
Explanation of basic concepts and methods illustrated by examples will be given in lectures. Lecture notes and readings will be given to students in advance.

<u>Tutorials:</u>
Tutorial problems will be given and explained in tutorial classes. Students will solve problems by applying what they have learnt in lectures. Students will understand social topics and mathematical strategies through interactive activities including free discussion, mock election, mock auction, games, etc. They can also seek advices from their tutor on their individual projects.</td></tr>
<tr><td>Assessment Methods in Alignment with Intended Learning Outcomes</td><td>
<table>
<tr><td rowspan="2">Specific assessment methods/tasks</td><td rowspan="2">% weighting</td><td colspan="6">Intended subject learning outcomes to be assessed (Please tick as appropriate)</td></tr>
<tr><td>a</td><td>b</td><td>c</td><td>d</td><td>e</td><td></td></tr>
<tr><td>1. Project</td><td>40</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td></td></tr>
<tr><td>2. Test</td><td>20</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td></td></tr>
<tr><td>3. Exam</td><td>40</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td></td></tr>
<tr><td>Total</td><td>100 %</td><td colspan="6"></td></tr>
</table>

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

<u>Project:</u>

Students will choose and explore a social topic and demonstrate their quantitative skills which they have learnt in lectures. Instructors will provide a list of topics which students can choose from. If students want to choose a topic not on the list, they have to get prior approval from the instructor. Students should choose topics by week 7 of the semester. A possible list of topics include: voting system of different countries; power index of different councils or organizations around the world (e.g., UN, European Union); and game theory and competition between two supermarket chains. The project will be a maximum of 5 pages long. Students will have to demonstrate the following four things in their project: (a) a clear explanation of social issue/conflict they have chosen; (b) use of their quantitative skills learned in lectures to solve the social issue/conflict; (c) justification of their methodology; (d) a coherent conclusion and the limitations of the methodology used. A rubrics based on parts (a) to (d) will be employed to assign a grade to the project. Turnitin will be used to assess plagiarism.

<u>Test and exam</u>

Written exam with multiple choice questions, short questions, long questions will be given to students in order to test both their quantitative</td></tr>
</table>

	skills and ability to explain concepts. Multiple choice questions test students' understanding in basic concepts and terminologies. Short questions cover application of quantitative methods introduced in social decision making, voting, fair division or strategy making with simple calculations. Long questions involve case studies in which students will use both qualitative and quantitative skills to analyze a given situation of a social issue and evaluate a fair, optimal solution.	
Student Study Effort Expected	Class contact:	
	▪ Lecture	26 Hrs.
	▪ Tutorial	13 Hrs.
	Other student study effort:	
	▪ Reading reference materials	30 Hrs.
	▪ Research and preparation for project	40 Hrs.
	Total student study effort	109 Hrs.
Reading List and References	Alan D. Taylor and Allison M. Pacelli, Mathematics and politics strategy, voting, power and proof, Springer 2008 Christoph Börgers, Mathematics of social choice : voting, compensation, and division, Society for Industrial and Applied Mathematics 2010 Jonathan K. Hodge, The mathematics of voting and elections : a hands-on approach, American Mathematical Society 2005 Wojciech Cwalina, Andrzej Falkowski and Bruce I. Newman, A cross-cultural theory of voter behavior, The Haworth Press, 2008 Jason Brennan, The ethics of voting, Princeton, 2011 Staffan I. Lindberg, Democratization by Elections, The Johns Hopkins University Press, 2009	

Subject Description Form

Subject Code	AMA1D07
Subject Title	Introduction to Cosmology
Credit Value	3
Level	1
Pre-requisite / Co-requisite/ Exclusion	Nil
Objectives	The main objectives of this subject are: a) To offer students a general understanding, at an elementary level, of cosmology from the observational and theoretical perspectives. b) To widen student's view on forefront knowledge and enhance their independent learning skills. c) To present the basic observational facts on which our understanding of the structure and evolution of the Universe is based d) To develop students' moral affection through raising their awareness on the roles of human beings in the nature and the universe.
Intended Learning Outcomes	a) Upon completion of the subject, students will be able to:understand the principles and laws that describe the observational/ experimental aspects of cosmology b) understand the dynamic interactive processes that take place in the Universe c) acquire the basic techniques to enhance the understanding on cosmology and science d) analyze data and make appropriate judgments on scientific phenomena e) conduct self-learning and contribute to team work in any disciplines/areas
Subject Synopsis/ Indicative Syllabus	• The visible universe. Galaxies, their structure and classification; determination of the cosmic distances; determination of the ages of the cosmic objects. • The observational basis of cosmology. The cosmological redshift; Hubble's law • Elementary theory of the Big Bang. Newtonian cosmology; the energy conservation equation; the expansion equation; cosmological models; the deceleration parameter; the age of the Universe • Elementary general relativity; the metric of the Universe; geometry of the Universe

<table>
<tr><td></td><td>

- Physics of the early Universe. Primordial nucleosynthesis; structure formation; the Cosmic Microwave Background; anisotropy of the Cosmic Microwave Background; the WMAP and Planck satellite observations
- The very early Universe. Problems of the standard cosmological models; inflationary models; quantum cosmology; the no-boundary proposal of Stephen Hawking
- The accelerating Universe. Supernovae as standard candles; the discovery of the recent acceleration of the Universe; dark energy and dark matter; the cosmological constant problem.

</td></tr>
<tr><td>Teaching/Learning Methodology</td><td>

<u>Lecture:</u>

This class will consist of 9 weekly 3-hour lectures and 4 sessions of student presentations. Each lecture will be dedicated to a particular topic relevant to the study of Cosmology. Both the mathematical and the physical aspects of the field will be stressed. We will explain the mathematics in layman's terms so as to accommodate students from different backgrounds. During the course of a lecture, pictures and videos will be presented to aid the students in obtaining an intuitive understanding. Weekly readings from classical and forefront popular science books will be assigned so that all students will have the opportunity to learn from the precise yet non-technical writing styles of cosmology scholars.

<u>Observations:</u>

We will offer three observation sessions for a total of 8 hours. The Objects that will be observed include the sun, stars, and other celestial bodies. The observations will be done using optical and radio telescopes. In each session, each student will complete a set of experimental exercises for evaluation. After each observation session, students are required to complete a laboratory report in analyzing real time data.

Visiting Hong Kong Astronomical Observatory (Ho Koon)

</td></tr>
<tr><td>Assessment Methods in Alignment with Intended Learning Outcomes</td><td>

<table>
<tr><td rowspan="2">Specific assessment methods/tasks</td><td rowspan="2">% weighting</td><td colspan="5">Intended subject learning outcomes to be assessed (Please tick as appropriate)</td></tr>
<tr><td>a</td><td>b</td><td>c</td><td>d</td><td>e</td></tr>
<tr><td>1. Assignment</td><td>20%</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td></tr>
<tr><td>2. Observation exercises</td><td>20%</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td></tr>
<tr><td>3. Test</td><td>30%</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td></td></tr>
<tr><td>4. Presentation</td><td>30%</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td></tr>
<tr><td>Total</td><td>100 %</td><td colspan="5"></td></tr>
</table>

</td></tr>
</table>

	Explanation of the appropriateness of the assessment methods in assessing the intended learning outcomes: There will be three observational work sheets, one take-home assignment, one mid-term test, and one final presentation. We guarantee that the observation equipments are enough to accommodate the needs for all the students. For instance, we have solar filters that every student can use for doing observation of the sun. <u>Final presentation;</u> At the end of the semester, students will divide into groups. Each group will deliver a presentation on an assigned topic related to cosmology. Through these presentations, students will have the opportunity to acquire the skills of self-learning, analysis and organization of material, critical thinking, teamwork, and communication, all of which are important skills that our university graduate should possess. Topics of presentation We will suggest some interesting topics to the students for doing project presentation. The topics are suggested as follows: Black Holes, Dark Matter, Dark Energy, 21cm Cosmology, String Cosmology, Gravitational Wave Cosmology, Large Scale Structure, Supernovae Cosmology, Brain-World Cosmology, Parallel Universe, etc.	
Student Study Effort Expected	Lecture and presentation	39 Hrs
	Observations	8 Hrs
	Other student study effort:	60 Hrs
	Total student study effort	107 Hrs
Reading List and References	An Introduction to Galaxies and Cosmology, by Mark H. Jones and Robert J. Lambourne, Cambridge University Press, 2015 Astronomy Today Volume 2 : Stars and Galaxies (8th Edition) by Eric Chaisson and Steve McMillan, Pearson Education, Inc., Addison-Wesley, 2014 Extragalactic Astronomy and Cosmology: An Introduction, by Peter Schneider, Springer, 2014 Cosmology: A First Course, by Marc Lachieze-Rey, Cambridge University Press, 2011 An Introduction to Modern Astrophysics, by B. W. Carroll and D. A. Ostlie, Pearson, 2013	

Subject Description Form

Subject Code	AMA1D08
Subject Title	The Mathematics behind Music
Credit Value	3
Level	1
Pre-requisite / Co-requisite/ Exclusion	Nil
Objectives	The subject aims to explore the connection between music and mathematics. We will present basic concepts in music theory and introduce the mathematical tools and theories to describe music in a simple and intuitive way. The students will gain a deeper understanding of both music and mathematics from the subject.
Intended Learning Outcomes	Upon completion of the subject, students will be able to: a. explain basic music theory concepts including pitch, scale, temperament, rhythm, chord and timbre and how they are related to mathematics. b. know how different music instruments produce their sounds and how mathematics can be used in designing, tuning and playing them. c. understand the mathematical tools used to describe and analyze music and apply them to simple examples. d. recognize the different branches of mathematics introduced in the subject and the role they play in the study of music. e. conduct self-learning and work with team members in searching relevant literature and present the findings.
Subject Synopsis/ Indicative Syllabus	1. Pitch and pitch class; arithmetic and geometric sequences; logarithm functions; equivalent classes. 2. Scales and temperament; Pythagorean scale; just intonation and equal temperament; rational and irrational numbers; continued fractions and approximation. 3. Musical rhythms from African drums to dance music; generating rhythms using Euclidean algorithm and Bjorklund's algorithm; describing rhythms by graphs. 4. Chords, harmony and Tonnetz; representing chords using lattices and geometry. Torus and other shapes of surfaces. 5. Variations of a musical theme; transposition and permutations; representing symmetry in music using groups. 6. Overtones and timbre; representing sounds by sinusoids and their sums.

<table>
<tr><td></td><td>7. Vibrations, frequency and sound of string, wind and percussion instruments; the mathematics behind the designing, tuning and playing of different instruments; strings of the violin and the harp; sizes of instruments in the string and the brass family; where to hit different percussion instruments when playing them and why.</td></tr>
<tr><td>Teaching/Learning Methodology</td><td>Lectures: Examples from various aspects of music will be presented in the lectures followed by introductions to the mathematical tools and theories to study and analyze them. There will be audio and video materials in each lecture and students will answer questions using online response systems. Students will be engaged in an active learning atmosphere in the lectures.

Tutorials: Students will work in groups on a set of problems and discussion questions related to the previous lecture guided by the tutor in tutorials. The problems will be similar to those in the test and exam. The discussion questions will encourage the students to think actively and share their knowledge and ideas.</td></tr>
<tr><td>Assessment Methods in Alignment with Intended Learning Outcomes</td><td>
<table>
<tr><td rowspan="2">Specific assessment methods/tasks</td><td rowspan="2">% weighting</td><td colspan="6">Intended subject learning outcomes to be assessed (Please tick as appropriate)</td></tr>
<tr><td>a</td><td>b</td><td>c</td><td>d</td><td>e</td><td></td></tr>
<tr><td>1. Participation</td><td>20%</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td></td><td></td></tr>
<tr><td>2. Test</td><td>20%</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td></td><td></td></tr>
<tr><td>3. Presentation</td><td>20%</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td></td></tr>
<tr><td>4. Exam</td><td>40 %</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td></td><td></td></tr>
<tr><td>Total</td><td>100 %</td><td colspan="6"></td></tr>
</table>
Explanation of the appropriateness of the assessment methods in assessing the intended learning outcomes:

Participation (20%): Students will answer questions in class during the lectures using online student response systems (e.g. uReply). The marks will be based on both participation (10%) and performance (10%) in answering the questions.

Midterm Test (20%): A 90-minute in class midterm test will contain multiple choice questions and short answer questions.

Presentation (20%): Students will be divided into groups of four to five and each group will give a presentation in the last two to three weeks of the semester. The lecturer will suggest a set of topics based on the course material. The students can also choose their own topics related to mathematics and music upon approval from the lecturer. The presentation should be 8-10 minutes long and marks will be given according to the content (10%), organization (5%) and performance (5%).

Final Exam (40%): The exam will also contain multiple choice questions and short answer questions. The questions will blend music theory with simple applications of mathematical tools introduced in class.</td></tr>
</table>

Student Study Effort Expected	Class contact:	
	▪ Lectures	26 Hrs.
	▪ Tutorials	13 Hrs.
	Other student study effort:	
	▪ Reading reference materials	30 Hrs.
	▪ Research and preparation for presentation	40 Hrs.
	Total student study effort	109 Hrs.
Reading List and References	Science of Percussion Instruments, Thomas D. Rossing, World Scientific, 2000 Music and Mathematics: From Pythagoras to Fractals, Edited by John Fauvel, Raymond Flood and Robin Wilson, Oxford University Press, 2003 The Discovery of Musical Equal Temperament in China and Europe in the Sixteenth Century, Gene J. Cho, Edwin Mellen Press, 2003 The Mathematical Theory of Tone Systems, Ján Haluš ka, Marcel Dekker, 2004 The Math Behind the Music, Leon Harkleroad, Cambridge University Press, 2006 Music: A Mathematical Offering, David J. Benson, Cambridge University Press, 2007 From Music to Mathematics, Gareth E. Roberts, Johns Hopkins University Press, 2016 Cool Math for Hot Music: A First Introduction to Mathematics for Music Theorists, Guerino Mazzola, Maria Mannone and Yan Pang, Springer, 2016 Tonal Harmony: With an Introduction to Post-Tonal Music, Stefan Kostka, Dorothy Payne and Byron Almén, McGraw-Hill, 8th edition, 2017	