PROPOSAL FOR THE INSTITUTION OF MATH 10[1]
Mathematics, Culture and Society

I. Identifying and Descriptive Information

A. Course Catalogue Description

1. **Course number:** Math 10
2. **Course Title:** Mathematics, Culture and Society
3. **Course Description:** Appreciation of the beauty and power of mathematics through the examination of its nature, development, utility, and relationship with culture and society.
4. **Prerequisite:** None
5. **Semester Offered** May be offered any semester or during midyear term
6. **Course Credit:** 3 units
7. **Number of Hours:** 3 hours/week
8. **Course Goal:** The ultimate goal of this course is to instill in the student an appreciation of mathematics, particularly the significant role that mathematics plays in society, both past and present. For this to occur, students must come to understand the nature of mathematics, its historical and contemporary role and to place the discipline properly in the context of other human intellectual achievements.

B. Rationale

In today's society, it is crucial for an informed citizen to: (i) have a broad general awareness of mathematics, its true nature, its current role in society, and its strengths and limitations; and (ii) have working competency in quantitative reasoning – a good sense of number, shape and size, the ability to assess numerical, statistical, and probabilistic evidence, and a level of comfort with abstractly presented reasoning. The proposed course addresses both needs but focuses primarily on the first goal as it lays the groundwork for the student to acquire needed mathematical and quantitative skills with confidence.

The course provides a view of mathematics as a living, growing, creative human endeavor that is regarded as both a science and an art. It aims to give students a feeling for the mathematical way of thinking and why mathematicians see it as an intellectually exciting discipline. Part of the course will involve students "doing math", but not in the traditional sense of solving equations or math problems, but engaging in a broad range of activities and exercises that provides opportunities for discovering different dimensions of math as a way of thinking and knowing.

In order to understand the development and role of mathematics, it is also important to examine the idea of math as an art, one that holds great aesthetic appeal to the practitioner. While math is commonly viewed as a tool and a useful language for research, the direct impact of mathematics in virtually all disciplines is often not realized by many. Thus a substantial portion of course will present and discuss some of the many important applications of mathematics in today's world.

The course makes no assumptions on the mathematical ability of the students and recognizes that students of the course will have different interests, prior experiences, and levels of mathematical exposure and training. The course is open to all UP students in any degree program (except BS Mathematics majors) but is more recommended for non-STEM majors and those with no math course in their curriculum.

The success of the course depends a lot on the competence and attitude of the teacher, who must engage the diverse studentry in a lively, stimulating, enjoyable and confidence-building manner. This is crucial as there may be many students who will be taking the course with low confidence in mathematics, aversion to and even loathing for the subject matter.

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[1] This course revises the existing Math 1 course offered by UPB, UPD, UP Cebu, UPV, UP Mindanao and UP Open U.

C. Course Outline

1. Course Outcomes:

Upon completion of the course, students must be able to:

CO 1. Explain the nature of mathematics as an intellectual and creative discipline;
CO 2. Recognize the importance of mathematics in various human activities;
CO 3. Relate the concepts of mathematics to their field/s of interest;
CO 4. Discuss the interplay of mathematics and society;
CO 5. Produce creative work inspired by mathematical ideas; and
CO 6. Discuss local and global issues and trends in mathematics.

Course Outcomes and Relationship to GE objectives

I *(introduced),* ***D*** *(demonstrated) or* ***R*** *(reinforced)*

Course Outcomes	GE Objectives*				
	A	B	C	D	E
1. Explain the nature of mathematics as an intellectual and creative discipline	I	D	D	I	
2. Recognize the importance of mathematics in various human activities	D	D	I		I
3. Relate the concepts of mathematics to their field/s of interest	D	D	D		
4. Discuss the interplay of mathematics and society	D	I	I	I	I
5. Produce creative work inspired by mathematical ideas	D	D	I		
6. Discuss local and global issues and trends in mathematics	D	D	D	I	I

**A Broaden intellectual and cultural horizons*
B Hone critical and creative thinking
C Develop a passion for learning and scholarship
D Cultivate a high sense of intellectual and moral integrity
E Foster a commitment to nationalism and social justice

2. Course Content

HRS	COURSE OUTLINE
4.5	**I. Introduction** A. Overview of the course B. Numeracy and quantitative literacy C. Student and public attitudes and perceptions of math D. Preliminary reflections on the nature and practice of math
15	**II. Nature of Math: math as a language, way of thinking, creative activity, and tool** A. Logic and reasoning a. Deductive reasoning b. Inductive reasoning B. Philosophical foundations a. Platonism b. Formalism: is mathematics created or discovered? C. Abstraction, symbols D. Axiomatic systems, rigor, proof, and truth in mathematics E. Sets: finite and infinite F. Numbers a. Numeration systems b. Real numbers, modular number systems G. Shapes a. Euclid's geometry and the discovery of non-euclidean geometries b. Finite and other modern geometries H. Functions a. Change, growth, and mathematical modeling b. A peek into the calculus I. Mathematics as the science of patterns

18	**III. Utility and Ubiquity of Mathematics: math in different disciplines** A. Arts and Humanities a. Math in visual arts and design: works of Alberti, Da Vinci, Escher and other artists (symmetry, proportion, perspectivity); tilings, tesselations, and weaving designs b. Math in music and dance c. Math in literature: Alice in Wonderland and the works of Lewis Carroll; poetry and literary forms: haiku, *tanaga, dalit* d. Math in folk and popular culture B. Social Sciences a. Voting theory and the mathematics of social choice b. Game theory and analysis of conflict and competition c. Group theory and kinship relations d. Social networks, small world networks, and the use of graphs C. Science, Technology and Engineering a. Math in nature: golden ratio, Fibonacci numbers b. Technology, computers, and their impact on mathematics c. Math in medicine and the life sciences d. Operations research, transportation, manufacturing, mathematical programming
7.5	**IV. Issues and Trends in Mathematics** *Suggested topics:* • Math and Gender • Truth and Certainty in Math • State of Mathematics and Mathematics Education in the Philippines • Ethnomathematics / Critical Mathematics / Humanistic Mathematics • Math and Computing • Great Problems: Solved and Unsolved

Notes on Topic Selection:

- The diversity of the student community and the richness of mathematics as a field of study imply a wide range and diversity of topics that can be covered in the course.
- An important feature is the flexibility of topic selection. The course goals and objectives can be achieved regardless of the specific concepts or topics that the course treats. The course adheres to the recommendation of the Mathematical Association of America that no particular selection of topics or teaching strategy should be universally adopted in a mathematics appreciation course.
- Principal unit (first level) topics and hours for each are specified but there is latitude in the selection of sub-topics to keep the course fresh and to capitalize on the strengths of the faculty and the local context.
- The choice of topics is guided by the following:
    - Accessibility: interesting math need not always be highly technical and built on layers upon layers of concepts
    - Applicability: connections between the math presented and concrete real-life situations are direct and immediate
    - Aesthetics: beauty and elegance often surface in the simplest ideas

3. Course Coverage

Week	Course Outcome	Topics	Teaching and Learning Activities	Teaching Strategies & Assessment Tools
1-2	**CO 1** **CO 2** **CO 4** **CO 5** **CO 6**	I. **Introduction** *4.5 hours* A. Overview of the course B. Numeracy and quantitative literacy C. Student and public attitudes and perceptions of math D. Preliminary reflections on the nature and practice of math	• Essay on personal perception on Math • Short film or audio-visual presentation	• Various teaching strategies such as lectures, audio-visual presentations, group discussions, film showing, math investigation and problem-solving exercises, reflection and reaction papers, and outdoor activities may be utilized throughout the course. • The teacher's enthusiasm for what is being done as well as the appropriateness of the strategy for the students in the course are generally more important than the actual strategy adopted. It is important however to include activities that engage the students in doing mathematics so that they gain a realistic sense of the process and nature of mathematics.
4-7	**CO 1** **CO 5**	**II. Nature of Math: math as a language, way of thinking, creative activity, and tool** *15 hours* A. Logic and reasoning B. Philosophical foundations Platonism, formalism: is mathematics created or discovered? C. Abstraction, symbols D. Axiomatic systems, rigor, proof, and truth in mathematics E. Sets F. Numbers 1. Numeration systems 2. Real numbers, modular number systems G. Shapes 1. Euclid's geometry and the discovery of non-euclidean geometries 2. Finite and other modern geometries H. Functions 1. Change, growth, and mathematical modeling 2. A peek into the calculus I. Mathematics as the science of patterns	• Group or individual project on numeration systems • Creative project using modular systems, numbers or geometric patterns • Thought activity, debate or discussion on creation vs discovery • Illustration of conceptual/abstract versus algorithmic thinking through famous proofs (infinitude of primes, 4-color theorem) • Midterm exam/assessment (mandatory)	
8-11	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5** **CO 6**	**III. Utility and Ubiquity: math in different disciplines** *18 hours* A. Arts and Humanities • Math in visual arts and design ○ works of Alberti, Da Vinci, Escher and other artists (symmetry, proportion, perspectivity) ○ tilings, tesselations and weaving designs • Math in music and dance • Math in literature ○ Alice in Wonderland and the works of Lewis Caroll ○ Poetry and literary forms: haiku, *tanaga, dalit* • Math in folk and popular culture	• Interview an artist, musician or professional and gather reflections on their profession or craft & its relation to mathematics • Create music video, short film, music composition or dance choreography that incorporates math ideas • Create/report on literary art that incorporates math ideas • Report on mathematical concepts found in UP symbols and icons: Oblation, chapels • Construct collaboration or friendship graphs	

		B. Social Sciences • Voting theory and the math of social choice • Game theory and analysis of conflict and competition • Group theory and kinship relations • Social networks, small world networks, and the use of graphs C. Science, Engineering and Technology • Math in nature: golden ratio, Fibonacci numbers • Technology, computers and their impact on mathematics • Math in medicine and the life sciences • Operations research, manufacturing, transportation and mathematical programming	• Conduct voting exercises using different voting methods • Play simple games (Sudoku, Game of Trumps, etc.) and analyze its rules and strategies • Do role playing, creating rules for marriage and kinship in clans	
12-14	**CO 1** **CO 2** **CO 3** **CO 4** **CO 6**	**IV. Issues and Trends in Mathematics** *7.5 hours* Suggested Topics: • Math and Gender • Truth and Certainty in Math • Mathematics in the Philippines • Ethnomathematics/ Critical Mathematics/ Humanistic Mathematics • Great Problems: Solved and Unsolved	Suggested Activities for Unit IV: • Play a game: Male "versus" Female (Math and Gender) • Visit a cockpit and study the math of "cristos" • Discussion: role of math in history and society and role of history and society in the development of math (cause or effect) • Debate (example: death of proof; is technology changing the way we do math?)	
15-16	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5** **CO 6**	**V. What is Mathematics, Really?** *3 hours* Integration and Summary	• Group or individual creative project on what is math, really • Final exam/assessment (mandatory)	

REFERENCES AND RESOURCES

There is no single textbook required for the course, but there are several excellent references that may be used as course readers (some are marked in the list below). References and materials from the different CUs will also be gathered and uploaded in an online repository that may be accessed by teachers and students.

General references and survey books on the nature and practice of math

1. P. Davis and R. Hersch, The Mathematical Experience, 1983*
2. P. Davis, R. Hersch and E.A. Marchisotto, The Mathematical Experience, Study Guides, Springer, 2011*
3. K. Devlin, The Language of Mathematics*, Holt Paperbacks, 2000 (and other works)
4. R. Elwes, Maths in 100 Key Breakthroughs*, Quercus Publishing, 2013.
5. T. Pirnot, Mathematics All Around

6. I. Stewart, The Problems of Mathematics, Oxford University Press, 1987 (and other works)
7. P. Tannembaum, Excursions in Modern Mathematics, 8th Ed., 2012.
8. A. Angel, C. Abbot and D. Runde, A Survey of Mathematics with Applications, 9th Ed., Pearson, 2012.
9. C. Miller, V. Heeren, and J. Hornsby, Mathematical Ideas, 12th Ed., Pearson Higher Education
10. R. Hersch, What is Mathematics, Really? Oxford University Press, 1999.
11. J. Bennet and W. Briggs. Using and Understanding Mathematics: A Quantitative Reasoning Approach, 5th Edition. Pearson Education, Inc., 2011.
12. J. A. Paulos, Innumeracy: Mathematical Illiteracy and its Consequences, 2008.

History and other specialized books

1. H. Eves, An Introduction to the History of Mathematics, 6th Ed.*, Cengage, 2012.
2. R. Cooke, The History of Mathematics, 3rd Ed., Wiley Publishers, 2012.
3. Frank Swetz, ed., From Five Fingers to Infinity: a Journey through the History of Mathematics, 1994.
4. C. Boyer and U. Merzbach, A History of Mathematics (3rd ed.) New York: John Wiley & Sons, Inc., 2010.
5. D. Burton, The History of Mathematics: An Introduction (7th ed). New York: McGraw-Hill, 2011.
6. M. Kline, Mathematics and the Search for Knowledge. New York: Oxford Univ. Press, 1985.
7. H.L. Resnikoff and R.O. Wells, Jr., Mathematics in Civilization
8. J. Mcleish, The Story of Numbers: How Mathematics Has Shaped Civilization
9. G. G. Joseph, The Crest of the Peacock: Non-European Roots of Mathematics, 3rd ed.
10. The Story of Mathematics – Prehistoric Mathematics to 20th Century Mathematics http://www.storyofmathematics.com/
11. D. R. Hofstadter, Gödel, Escher, Bach: An Eternal Golden Braid
12. Harrison White, An Analysis of Kinship Systems, 1963
13. M. Emmer, Math and Culture II: Visual Perfection: Math and Creativity
14. Dunham, W. Journey Through Genius: The Great Theorems of Mathematics, Penguin, 1991.
15. E.A. Abbott, Flatland: the Romance of Many Dimensions, 1884
16. L.B. Alberti, On Painting and on Sculpture: the Latin Texts of *De Pictura* and *De Statua*, 1972, Phaidon Press

Essays and articles

1. E. Wigner, The Unreasonable Effectiveness of Mathematics in the Natural Sciences, 1960*
2. I. Lakatos, Proof and Refutation*
3. J. Horgan, The Death of Proof, Scientific American, 1993
4. N. Baylas IV, T. Rapanut and M.L.M. de las Peñas, Weaving Symmetry of the Philippine Northern Kankanaey, Bridges 2012: Mathematics, Music, Art, Architecture and Culture
5. The algebra of the weaving patterns, gong music and kinship system of the Kankana-ey of Mountain *Province,* Discipline of Mathematics, UP College Baguio, 1996
6. S. Lipsey and B. Pasternack, Math in Literature, math.unipa.it/~grim/SiLipsey.PDF

Films and documentaries

1. BBC Documentary: The Story of Maths*
   Episode 1: The Language of the Universe, http://www.youtube.com/watch?v=IJx6W6vAAc0
   Episode 2: The Genius of the East, http://www.youtube.com/watch?v=_YyQWR44dpY
   Episode 3: The Frontiers of Space, http://www.youtube.com/watch?v=R48s8-EwLt8
   Episode 4: To Infinity and Beyond, http://www.youtube.com/watch?v=_ITgz_3UylQ
2. Jin Akiyama's TV program episodes
3. Flatland: the Movie, 2007, an animated film by Dano Johnson and Jeffrey Travis
4. Flatland the Film, 2007, a computer-animated film by Ladd Ehlinger Jr.
5. A Beautiful Mind, 2001, a Ron Howard film
6. Proof, 2005, a John Madden film
7. Good Will Hunting, 1997, a Gus van Sant film
8. Fermat's Last Tango, 2001, a David Stern film
9. Pi, 1998, a Darren Aronofsky film
10. Episodes from Numb3rs, 2005-2010, a CBS crime-drama television series

Video clips and podcasts

1. TED Ed Lessons Worth Sharing, www.ed.ted.com/series/math-in-real-life (Math in Real Life series, 48 videos)
2. The Maya Base-20 Number System, www.youtube.com/watch?v=Ybvb7oy_WV0&list=PLQHIZp6bsugkfuu1QDlGicupcSUcZqdpR
3. Reasoning and Logic, www.youtube.com/watch?v=I2FBOTwYlic&list=PLQHIZp6bsugkfuu1QDlGicupcSUcZqdpR
4. Deductive vs. Inductive Reasoning, http://www.youtube.com/watch?v=U0VQUKSJ-b8
5. 25_divided_by_5_equals_14, http://youtube.com
6. G. Ziegler, Teaching and Learning "What is Mathematics", www.icm2014.org/vod/
7. K. Schaffer and E. Stern, Math Dance Ensemble, www.mathdance.org, also on Youtube and TEDx
8. Episodes from TED Ed Math in Real Life Series, www.ed.ted.com/series/math-in-real-life

Websites and Homepages

1. The Geometry Junkyard, http://www.ics.uci.edu/~eppstein/junkyard/
2. *Mathematical Association of America, http://www.maa.org*
3. Eric Weisstein's Math World, http:/www.mathworld.wolfram.com
4. Interactive Mathematics Miscellany and Puzzles, http://www.cut-the-knot.com
5. MacTutor History of Math Archive, http:// www-groups.dcs.st-and.ac.uk/~history/index.html
6. Math in the Movies, http://www. http://world.std.com/~reinhold/mathmovies.html
7. Plus Magazine, http://www. http://plus.maths.org/content/
8. Math Archives, http://archives.math.utk.edu/

**Highly recommended reference*