SUBJECT: Mathematics

MATH 111 Pre-Statistics and Modeling (2)

For students who wish to further their mathematical and problem-solving skills, with emphasis on questions relevant to statistics and finite mathematics. Students will: create and interpret data from graphs and tables; understand several representations of quantitative data and articular the connections among them; use and understand mathematical notation; model relationships in data with linear functions and graphs; apply basic counting principles to elementary discrete probability. No pre-requisites.

MATH 114 Mathematics Exploration (4)

A course to enrich the students' liberal arts education by presenting the spirit and some insights of mathematics. The course will emphasize understanding over techniques. Topics will illustrate the nature of contemporary mathematics and the relationship between mathematics and our cultural heritage. Some possible topics include: algorithms, exotic geometries, finance, map coloring, graphs, groups and mathematical modeling. Prerequisites: three years of college preparatory mathematics & (ACT 17 or Statistics QSI) or permission of instructor.

MATH 114A Islamic Art: Where Geometry and Culture Meet (4)

This course combines classroom learning at CSB/SJU during CD mod and ends with an experiential component abroad. A course to enrich the students' liberal arts education by presenting the spirit and some insights of mathematics. The course will emphasize understanding over techniques. Topics will illustrate the nature of contemporary mathematics and the relationship between mathematics and our cultural heritage. Some possible topics include: algorithms, exotic geometries, finance, map coloring, graphs, groups and mathematical modeling. Prerequisites: three years of college preparatory mathematics & (ACT 17 or Statistics QSI) and permission of instructor.

MATH 115 Pre-Calculus Mathematics (2)

Properties of polynomial, trigonometric, exponential functions. For the student who needs further preparation for calculus. Prerequisites: three years of college preparatory mathematics. Does not satisfy Mathematics Common Curriculum Requirement.

MATH 118 Essential Calculus (4)

Preliminary concepts; derivatives, integrals and the concept of limit; application of differentiation and integration; calculus of several variables; exponentials, logarithms and growth problems. Other topics may include differential equations and probability theory. Prerequisites: four years of college preparatory mathematics & MATH proficiency or QSI or MATH 115 or permission from the chair of the mathematics department.

MATH 119 Calculus I (4)

Definition and nature of limits, continuity, derivatives of polynomial, algebraic and trigonometric functions and applications. Definite integrals and application. Prerequisites: four years of college preparatory mathematics & MATH proficiency or Calculus QSI or MATH 115 or permission from the chair of the mathematics department. Note: Credit will be awarded for MATH 119 upon completion of MATH 120 with a grade of C or higher.

MATH 120 Calculus II (4)

Continuation of applications of the integral. Infinite series, Taylor's theorem, methods of integration, introduction to functions of several variables. Additional topics may include complex numbers, polar coordinates, parametric equations, approximation methods, differential equations. Prerequisite: 119 or permission of the chair of the mathematics department.

MATH 121 Fundamentals of Mathematics (4)

Basic concepts of sets, numeration, structure of number systems, arithmetic and algebraic operations, problem solving, and other topics to prepare students for elementary school mathematics teaching. Prerequisites: three years of college preparatory mathematics & (ACT 17 or Statistics QSI) or MATH 111 or permission of instructor.

MATH 122 Finite Mathematics (4)

Mathematics for students in the life, social and management sciences. Topics chosen from symbolic logic, set theory, combinatorial analysis, probability, linear equations, vectors, matrices, mathematics of finance, linear programming, Markov chains and matrix games. Prerequisites: three years of college preparatory mathematics & (ACT 21, SAT 530, or Statistics QSI 17), MATH 111 or permission from the chair of the mathematics department.

MATH 124 Probability and Statistical Inference (4)

Graphs and charts, mean, median and other measures of location. Terminology and rules of elementary probability; normal distribution, random sampling, estimation of mean, standard deviation and proportions, correlation and regression, confidence intervals, tests of hypotheses. Prerequisites: three years of college preparatory mathematics & (ACT 21 or Statistics QSI) or MATH 111 or permission from the chair of the mathematics department.

MATH 125 Discrete Mathematical Modeling (4)

This course is an introduction to mathematical modeling based on the use of elementary functions to describe and explore real-world phenomena and data. Linear, exponential. Logarithmic and polynomial function models are examined closely and are applied to real-world data in course assignments. Students will study three main areas of modeling: optimization, dynamical systems and probability theory using discrete models and methods. Examples of topics covered may include Linear Programming, Population Growth, Mathematics of Finance, Regression (linear and non-linear), Probability distributions, and Markov Chains. Prerequisites: Three years of college preparatory mathematics & (ACT Math 21 or Pre-Statistics QSI) or MATH 111 or permission from the chair of the mathematics department.

MATH 127 Number Systems (1)

Topics to include sets, functions, other number bases, elementary number theory, rational and irrational numbers and problem solving strategies related to these topics. Prerequisite: Elementary Education majors who have completed Math 118, Math 119 or the equivalent, with a grade of C or better.

MATH 180 Fundamentals of Mathematics II (4)

Continuation of 121. Probability and statistics, geometry, discrete mathematics including combinatorics and graph theory, and other topics to prepare students for middle school mathematics teaching. Prerequisite: 121.

MATH 239 Linear Algebra (4)

Systems of linear equations, matrices and matrix operations, vector spaces, subspaces, linear independence, basis and dimension, linear transformations, eigenvalues and eigenvectors, inner products, elementary proofs appropriate to o the course content, and selected applications. The selected applications will include solving first order linear ordinary differential equations, second order linear differential equations, and systems of differential equations. Prerequisite: 120 or permission of the chair of the mathematics department.

MATH 271 Individual Learning Project (1-4)

Supervised reading or research at the lower-division level. Permission of department chair required. Consult department for applicability towards major requirements. Not available to first-year students.

MATH 304 Foundations and Structures of Mathematics (4)

The basic theme of this course is mathematical thinking and writing. Emphasis will be placed on formulating and writing proofs. The course will cover topics in the following areas: logic, sets, relations, functions, counting, graph theory, infinite sets, algebraic structures and the real number system. Additional topics as time permits. Prerequisite: 120.

MATH 305 Multivariable Calculus (4)

Topics selected from Geometry of Rn, differentiation in Rn, vector-valued functions, optimization, multiple integrals, line and surface integrals, vector analysis and introduction to differential forms. Prerequisite: 239. Fall.

MATH 307 History of Mathematics (1-4)

Advanced level independent guided readings, discussions and written projects on the history of mathematics. Prerequisite: instructor's consent. Replaces: MATH 300, 301, 302, and 303.

MATH 310 Foundations and Structures of Mathematics (4)

The basic theme of this course is mathematical thinking and writing. Emphasis will be placed on formulating and writing proofs. The course will cover topics in the following areas: logic, sets, relations, functions, counting, graph theory, infinite sets, algebraic structures and the real number system. Additional topics as time permits. Prerequisite: MATH 120.

MATH 315 Operations Research (4)

Topics selected from: linear programming, duality theory, dynamic and integer programming, graph-theoretic methods, stochastic processes, queuing theory, simulation, non-linear programming, PERT/CPM. Applications to social and natural sciences and business. Prerequisite: 239. Fall in even years.

MATH 318 Applied Statistical Models (4)

The relationships among variables in real data sets will be explored through the theory and application of linear models. The focus of the course will be on building such models, assessing their adequacy, and drawing conclusions. Statistical computing programs will be used to analyze the data. Prerequisite: 239. Spring in even years.

MATH 322 Combinatorics and Graph Theory (4)

Basic enumerative combinatorics and graph theory including counting principles, generating functions, recurrences, trees, planarity and vertex colorings. Additional topics at the discretion of the instructor. Prerequisite: 239. 241 recommended. Spring in odd years.

MATH 331 Algebraic Structures I (4)

Definitions and basic properties of sets and relations, groups, rings, ideals, integral domains, fields, algebras and applications. Prerequisites: 239 & 241 or 304. Spring and fall in even years.

MATH 332 Algebraic Structures II (4)

Continuation of 331, additional topics in Algebra such as: Sylow theorems, coding theory, free groups, Euclidean rings, extension fields, Galois theory, categories, functors, tensor products. Prerequisite: 331. Spring in odd years.

MATH 333 Geometry I (4)

Foundations of geometry, study of axiom systems for finite geometries and Euclidean geometry, topics in synthetic geometry; introduction to hyperbolic and other geometries. Geometric transformation theory and classification of geometries by transformation groups. Prerequisite: 239. Fall in odd years.

MATH 337 Differential Equations (4)

The concept of a solution, tangent fields, the existence and uniqueness theorem and its implications, elementary solution techniques, series and numerical solutions, linear equations and systems, Laplace transforms, applications. Prerequisite: 239. Spring.

MATH 338 Numerical Analysis. (4)

Numerical algorithms and error estimations, solutions of linear and nonlinear equations and systems, numerical solutions of differential equations, numerical integration, interpolation and approximation techniques, matrix methods and power series calculations. Prerequisite: 239 and familiarity with computer programming. Spring in even years.

MATH 339 Mathematical Modeling (4)

Mathematical modeling is the art of finding mathematical descriptions of real-world phenomena, with the goal of attaining a deeper understanding of those phenomena. The mathematical tools will vary according to the

application. This course will cover both continuous and discrete mathematical models. Applications will be drawn from a variety of fields, such as population dynamics, economics, and physical sciences. Prerequisite: Math 239. Fall in odd years.

MATH 340 Topics in Advanced Mathematics (4)

Content varies from semester to semester. Topics will be chosen from both pure and applied mathematics and may include algebraic coding theory, cryptology, number theory, mathematical modeling, mathematical logic, complex analysis, topology, dynamical systems, applications to computer science. May be repeated for credit when topics vary. Prerequisite: 239. Additional prerequisites possible depending on the topic. Fall and Spring in even years.

MATH 340A Mathematical Modelling in Biology (4)

Traditional approaches to mathematical modelling in biology have relied primarily on differential equations models. However, new approaches have and are being developed that rely instead on discrete methods, such as those coming from graph theory, polynomial manipulation and elementary linear algebra. For example, gene regulatory networks have been successfully modelled using Boolean logic. The spread of tick-borne diseases and methods of control have been well described using agent-based models. Graph theoretic models have been used to explore aspects of neuronal network connectivity. This course will survey a variety of discrete modelling approaches, including Boolean models, polynomial dynamical systems, graph theory, agent based modelling, and hidden Markov models. Emphasis will be on examples and applications, which will be drawn from various areas of biology, including problems in gene regulation, population dynamics and neuroscience. The necessary mathematical background will be included in the course. Prerequisite: Math 239 or permission of instructor

MATH 340C A Mathematician's Guide to Music (4)

What's so special about sine waves and to what extent can sound be broken into sine waves? Why does the modern scale have twelve notes and are there other (mathematical) possibilities? How does a violin produce sound, and why is it so different from the way a clarinet or a drum produces sounds? We will answer these and other questions regarding the connections between music and mathematics. Topics will include, but are not limited to, Fourier analysis, consonance and dissonance, modeling different types of instruments, scales, temperaments, and symmetry in music. Prerequisite: Math 239 or permission of the instructor

MATH 340D History of Geometry & Algebra (4)

Geometric and algebraic thinking have been at the heart of mathematics throughout its 4000 year history. While other courses mention what previous mathematicians accomplished, they too rarely consider how those mathematicians approached the mathematics. We will delve into translations of original mathematical texts, seeking to understand how mathematics developed. Some past insights turned out to be dead ends, some needed centuries to bear fruit. Our sources will range from problems found in Babylonian clay tablets to Archimedes' elegant proofs on to Descartes' fusion of algebra and geometry and beyond, with many stops on the way. An historical approach can provide insight to all mathematics majors and will especially benefit future high school teachers. Prerequisite Math 239.

MATH 340E Knot Theory (4)

One of the better jokes about Knot theory is that students enjoy it because it's "not theory"! But if it's "not theory" what is it? Knot theory is a relatively new branch of mathematics with historical roots reaching back to the late nineteenth century. The main project of Knot Theory is to devise mathematical tests for distinguishing one knot from another. Investigators in knot theory use ideas and techniques from several important branches of mathematics--primarily topology, algebra and combinatorics--to get some insight into the fundamental classification problem. In this course our first task will be to devise a careful definition of a knot; the rest of the course will be devoted to learning about various properties of knots and practicing the various mathematical techniques which are used to describe and distinguish them. Toward the end of the course we'll take time to learn about some of the current applications of knot theory in biology, chemistry and physics. Prerequisite: Math 239

MATH 340F Mathematics of Finance (4)

This course is an introduction to the mathematical models used to understand financial markets, evaluate financial instruments, and to measure and manage risk. The goal is to understand how the sophisticated mathematical models derive from basic principles in economics, and to provide the necessary mathematical tools for their analysis.

Topics will include probabilistic discrete time models and how they are used in conditional expectation, martingales, arbitrage pricing, hedging and, culminating with the Black-Scholes formula for options. Prerequisite MATH 239

MATH 340G A Study of the Game Lights Out (4)

The game LIGHTS OUT! is played on a 5 × 5 square grid of buttons; each button may be on or off. Given an initial configuration of buttons that are on, the object of the game is to turn all the lights out. Pressing a button changes the on/off state of the button pressed and of all its vertical and horizontal neighbors. In this course, we will explore topics in graph theory and linear algebra to help us investigate the game applied to graph families such as paths, cycles, and complete graphs before looking at the game applied to Cartesian Product graphs. Finally, we will explore a graph family that the game has never been applied to. Prerequisite MATH 239

MATH 340H PICMath (4)

Students will work in groups on a problem from the industrial, government, or non-profit sector. Contact instructor regarding prerequisites and enrollment. Prerequisite MATH 239 and permission of the instructor.

MATH 341 Fourier Series and Boundary Value Problems (4)

Separable partial differential equations from theoretical physics. Fourier series, convergence, orthogonal systems. Fourier integrals. Sturm-Liouville theory, solutions to boundary value problems. Applications. Prerequisite: 239. Spring in odd years.

MATH 343 Analysis I (4)

Set theory, real numbers, topology of Cartesian spaces, Heine-Borel Theorem, sequences, series, convergence, continuity, differentiation, integration. Prerequisites: 239 and 241 or 304. Spring and fall in odd years.

MATH 344 Analysis II (4)

Topics selected from the following: mapping theorems and extremum problems, Riemann-Stieltjes integral, main theorems of integral calculus, point set topology, Lebesque integral, functions defined by integrals, convergence theorems. Prerequisite: 343.

MATH 345 Mathematical Statistics I (4)

Probability spaces, random variables, statistics and sampling distributions, statistical hypotheses and decision theory, statistical inference, estimation. Prerequisite: 239. Offered Fall.

MATH 346 Mathematical Statistics II (4)

Topics selected from the following: sampling, order statistics, Monte Carlo methods, asymptotic efficiencies, maximum likelihood techniques, inference, multivariate normal, analysis of variance, regression, correlation. Prerequisite: 345. Spring in odd years.

MATH 348 Complex Variables (4)

Topics will generally include properties of complex numbers; complex functions and their derivatives; analyticity; Cauchy's Theorem and related results; series representations of functions; contour integration and the theory of residues. Additional topics at the discretion of the instructor. Prerequisite: 239. Spring in even years.

MATH 371 Individual Learning Project (1-4)

Supervised reading or research at the upper-division level. Permission of department chair and completion and/or concurrent registration of 12 credits within the department required. Consult department for applicability towards major requirements. Not available to first-year students.

MATH 395 Mathematics Capstone (2)

Critical analysis of readings or topics and/or an in-depth investigation leading to a project. The course will be structured as a seminar. The instructor will select the subject matter. Students will present and discuss the material

of the course, and complete regular assignments (short papers or problem sets). Prerequisite: Senior standing, 241 or 304 and completion of at least two 300 level mathematics courses.

MATH 397 Internship (1-16)

Completed Application for Internship Form REQUIRED. See Internship Office Web Page.