



**Texas A&M International University**  
**College of Arts and Sciences**  
**Department of Mathematics and Physics**

**Student Learning Outcomes**

(Updated on 09/30/2021)

Courses included in this document:

- **Mathematics**

MATH 1314 College Algebra  
MATH 1316 Plane Trigonometry  
MATH 1324 Business Mathematics I  
MATH 1325 Business Mathematics II  
MATH 1332 Mathematics for Liberal Arts  
MATH 1342 Introductory Statistics  
MATH 1350 Fundamentals of Mathematics I  
MATH 1351 Fundamentals of Mathematics II  
MATH 2330 Elementary Geometry  
MATH 2412 Pre-Calculus  
MATH 2413 Calculus I  
MATH 2414 Calculus II  
MATH 2415 Calculus III  
MATH 3195 Seminar  
MATH 3310 Introduction to Linear Algebra  
MATH 3325 Geometry  
MATH 3330 Ordinary Differential Equations  
MATH 3360 Statistical Analysis  
MATH 3365 Discrete Mathematics  
MATH 3371 Communication in Mathematics  
MATH 3390 Principles of Math for Elem Ed  
MATH 4305 Number Theory  
MATH 4310 Abstract Algebra I  
MATH 4315 Abstract Algebra II  
MATH 4330 Numerical Linear Algebra  
MATH 4335 Advanced Calculus  
MATH 4340 Numerical Analysis I  
MATH 4345 Complex Variables  
MATH 4352 Internship in Mathematics  
MATH 4360 General Topology  
MATH 4365 Geometry of Curves and Surfaces  
MATH 4385 History of Mathematics  
MATH 4390 Mathematics in the Middle and High Schools  
MATH 4395 Senior Mathematics Project  
MATH 5191 Mathematics Seminar  
MATH 5290 Research Methods in Mathematics  
MATH 5303 Number Theory I  
MATH 5305 Real Analysis I  
MATH 5306 Linear Algebra  
MATH 5316 Graph Theory  
MATH 5320 Complex Variables I

MATH 5330 Abstract Algebra I  
MATH 5350 Ordinary Differential Equations I  
MATH 5355 Advanced Topics in Mathematics  
MATH 5360 Partial Differential Equations  
MATH 5365 Topology  
MATH 5367 Numerical Methods for PDE I  
MATH 5370 Mathematical Modeling  
MATH 5375 Probability  
MATH 5395 Graduate Research in Mathematics  
MATH 5398 Thesis I  
MATH 5399 Thesis II

- **Statistics**

STAT 5300 Categorical Data Analysis  
STAT 5305 Applied Data Analysis  
STAT 5306 Generalized Linear Models with Applications  
STAT 5310 Statistical Methods for Clinical Trials  
STAT 5322 Theory of Sampling and Surveys  
STAT 5327 Computational Methods in Statistics  
STAT 5328 Regression and Applied Time Series Models  
STAT 5329 Analysis of Variance in Experimental Design Models  
STAT 5340 Quality Control and Improvement  
STAT 5341 Applied Multivariate Analysis  
STAT 5387 Statistical Models for Spatial Data  
STAT 5390 Case Seminar in Applied Statistics

- **Physics and Astronomy**

ASTR 1111 Planetary Astronomy Laboratory  
ASTR 1311 Planetary Astronomy  
ASTR 1112 Stellar Astronomy Laboratory  
ASTR 1312 Stellar Astronomy  
PHYS 1101 General Physics I Laboratory  
PHYS 1301 General Physics I  
PHYS 1102 General Physics II Laboratory  
PHYS 1302 General Physics II  
PHYS 1170 Survey of Physical Science Laboratory  
PHYS 1370 Survey of Physical Science  
PHYS 2125 University Physics I Laboratory  
PHYS 2325 University Physics I  
PHYS 2126 University Physics II Laboratory  
PHYS 2326 University Physics II  
PHYS 3310 Modern Physics  
PHYS 3320 Electromagnetic Field Theory  
PHYS 4315 Mathematical Methods of Physics

This document is possible by the joint work of all faculty of the Department of Engineering, Mathematics, and Physics, and was prepared by the Assessment Committee: Dr. Pablo Biswas (2010-2014), Dr. Eduardo Chappa (2009-2012), Dr. Rohitha Goonatilake (2009), Dr. Runchang Lin (2011-2014), Dr. David K. Milovich Jr. (2009-2014), Dr. Qingwen Ni (2009-2014), and Dr. Rafic Bachnak (2009-2013). In Fall 2021, Dr. Hongwei Wang undertook the revisions and updates to the list of Student Learning Outcomes on behalf of the Department of Mathematics and Physics.

## Department of Mathematics and Physics

### MATH 1314 College Algebra

**Adoption date: Fall 2021.**

#### **COURSE DESCRIPTION**

The fundamentals of algebra; polynomials and graphs; conic sections; systems of linear equations, matrices; sequences and series; mathematical induction and the binomial theorem. Prerequisites: Completion of Texas Success Initiative (TSI) mathematics requirements, appropriate level developmental course sequence, an minimum ACT Mathematics score of 19 with an ACT Composite score of 23 or above, a minimum SAT Mathematics score of 500 with a SAT Total score of 1,070 or above, or a Redesigned SAT Mathematics score of 530 or above. TCCN: MATH 1314

#### **STUDENT LEARNING OUTCOMES**

Upon successful completion of this course, the student will be able to:

- Demonstrate and apply knowledge of properties of functions, including domain and range, operations, compositions, and inverses.
- Recognize and apply polynomial, rational, radical, exponential and logarithmic functions and solve related equations.
- Apply graphing techniques.
- Evaluate all roots of higher degree polynomial and rational functions.
- Recognize, solve and apply systems of linear equations using matrices.
- Perform the expansion of the positive integer powers of a binomial expression.
- Apply theorems and formulas such as the quadratic formula, the distance formula, equation of circles and other conic sections, and remainder and factor theorems.
- Perform computations with the general term of a sequence, and add the terms of a geometric and an arithmetic sequence.
- Prepare and submit a written paper using phrases commonly found in mathematical literature.

## Department of Mathematics and Physics

### MATH 1316 Plane Trigonometry

**Adoption date: April 24, 2009.**

#### **COURSE DESCRIPTION**

Trigonometry, analytic trigonometry, applications of trigonometry, complex numbers, polar coordinates and parametric equations. Prerequisite: One or more of an ACT Mathematics score of 27 or above, an SAT Mathematics score of 630 or above, a COMPASS score of College Algebra 51 or above, or MATH 1314.

#### **STUDENT LEARNING OUTCOMES**

Upon successful completion of this course, the student will be able to:

- recall the definition of the six basic trigonometric functions: sine, cosine, tangent, cotangent, secant and cosecant, as well as their basic periodicity properties, graphs and symmetries;
- identify the inverse trigonometric functions, together with their domains and graphs, and use them to solve trigonometric equations;
- verify trigonometric identities and their relative relationships, such as use the value of the trigonometric function of an angle to compute the value of a trigonometric function of the same angle, or double that angle, or half that angle;
- use the sine and cosine law to solve a triangle;
- perform complex number operations using polar form and use D'Moivre's formula to compute the n-th root of a complex number;
- use trigonometry to solve problems related to parametric equations;
- use trigonometry to solve problems related to polar coordinates;
- use vectors and related trigonometry concepts to solve problems in geometry and physics.

# Department of Mathematics and Physics

## MATH 1324 Business Mathematics I

**Adoption date: April 24, 2009.**

### **COURSE DESCRIPTION**

Systems of linear equations and matrices; linear programming; mathematics of finance; limits, continuity, derivatives. Prerequisite: One or more of an ACT Mathematics score of 25 or above, an SAT Mathematics score of 600 or above, a COMPASS score of College Algebra 35 or Algebra 81 or above, or MATH 1314.

### **STUDENT LEARNING OUTCOMES**

Upon successful completion of this course, the student will be able to:

- set up and solve problems involving simple and compound interest, as well as future and present value of an annuity;
- solve systems of linear equations using the Gauss-Jordan elimination method;
- set up and solve problems in linear programming; that is, use graphical methods, as well as the simplex method (including the dual method) to maximize linear objective functions. Students will also be able to solve linear optimization problems with mixed constraints;
- apply basic concepts from Calculus, such as limit, continuity and the physical and geometrical interpretation of Derivatives to solve problems in Business and Economics;
- set up and solve problems that use derivative techniques such as the product, quotient and chain rule.

## **Department of Mathematic and Physics**

### **MATH 1325 Business Mathematics II**

**Adoption date: April 24, 2009.**

#### **COURSE DESCRIPTION**

Applications of the derivative, anti-derivatives, and techniques of integration; functions and calculus of several variables. Prerequisite: MATH 1324.

#### **STUDENT LEARNING OUTCOMES**

Upon successful completion of this course, the student will be able to:

- use derivative techniques, such as the product, quotient or chain rule to solve problems in Business and Economics;
- use derivative tests, like the first and second derivative, to graph functions, and apply these techniques to problems in optimization;
- interpret the definite integral of a function geometrically as the area of a region, and apply the Fundamental Theorem of Calculus to compute antiderivatives and definite integrals of continuous functions;
- use methods of integration, such as substitution or integration by parts to compute antiderivatives and definite integrals. Students will apply these techniques to solve problems in the computation of areas between curves, or apply them to problems in Business and Economics;
- apply techniques of calculus of several variables, such as analyzing the second partial derivatives or Lagrange Multipliers, to find the maximum and minimum of a function of several variables;
- use double integrals to compute volumes of solids in three dimensional space.

## **Department of Mathematics and Physics**

### **MATH 1332 Mathematics for Liberal Arts**

**Adoption date: November 19, 2010, revised Fall 2018**

#### **COURSE DESCRIPTION**

This course is designed to enhance mathematical literacy and to stimulate interest in appreciation for mathematics and quantitative reasoning as valuable tools for addressing issues in a constantly changing society. Topics may include, at an introductory level, logical reasoning and problem solving through mathematical games and puzzles; sets, relations, and functions; counting and number concepts (number theory and infinity). Prerequisite: Completion of Texas Success Initiative (TSI) Mathematics requirements or appropriate level developmental course sequence.

#### **STUDENT LEARNING OUTCOMES**

Upon successful completion of the course, the student will be able to:

- identify, graph and solve problems involving functions.
- understand the basic concepts of sets and logic.
- demonstrate knowledge of basic concepts in financial management.
- use basic concepts of statistical reasoning to summarize data and form conclusions.
- find the probability of an event and formulate mathematical or management decisions from the information.

## **Department of Mathematics and Physics**

### **MATH 1342 Introductory Statistics**

**Adoption date: April 24, 2009.**

#### **COURSE DESCRIPTION**

Topics include organization of data; probability; random variables; the normal distribution; inferences; chi-square; regression and correlation; analysis of variance; and non-parametric statistics. Prerequisite: MATH 1314.

#### **STUDENT LEARNING OUTCOMES**

Upon successful completion of this course, the student will be able to:

- learn to organize and summarize data as a way to study descriptive statistics;
- find the probability of a compound event and the conditional probability of an event;
- construct a probability distribution and perform relevant calculations, such as mean and standard deviation;
- use the Central Limit Theorem to solve problems;
- determine confidence intervals;
- solve hypothesis testing problems;
- perform calculations for the correlation coefficient and the regression line for a set of ordered pairs.



## **Department of Mathematics and Physics**

### **MATH 1350 Fundamentals of Mathematics I**

**Adoption date: April 24, 2009.**

#### **COURSE DESCRIPTION**

Sets, relations, functions, number system, and elementary number theory. This course cannot be used to fulfill Core Curriculum requirements. Prerequisite: MATH 1314.

#### **STUDENT LEARNING OUTCOMES**

Upon successful completion of this course, the student will be able to:

- illustrate, explain and exemplify various models of whole and signed numbers and of arithmetic operations with them;
- illustrate and explain the place value systems and the paper-and-pencil algorithms (both standard and alternative) for performing arithmetic operations, in base ten as well as bases other than ten;
- illustrate, explain and exemplify various models of fractions, and models of and strategies for arithmetic operations with them;
- illustrate, explain and exemplify the concepts of ratio, percentages and proportions, and solve related problems by flexibly applying proportional reasoning;
- develop, analyze, compare and evaluate strategies for performing arithmetic operations, including and in particular mental computation and estimation;
- use factor, multiple, prime factorization and relatively prime numbers to solve problems about integers; and,
- use algebraic symbols to illustrate mathematical situations, structures and relationships as algebraic expressions, identities and equations.

## **Department of Mathematics and Physics**

### **MATH 1351 Fundamentals of Mathematics II**

**Adoption date: November 19, 2010.**

#### **COURSE DESCRIPTION**

Probability, statistics, and geometry. This course cannot be used to fulfill Core Curriculum requirement. Prerequisite: MATH 1350.

#### **STUDENT LEARNING OUTCOMES**

Upon successful completion of the course, the student will be able to:

- recognize, describe and solve descriptive statistics problems, e.g. graphical descriptive statistics, measures of central tendency, measures of variation;
- recognize, describe and solve elementary probability problems, e.g. counting, conditional probability, expected value;
- recognize, describe, and solve elementary measurement problems, e.g. linear, surface and area measures;
- recognize, describe, and use elementary Euclidean geometry in problem solving, e.g. congruency and similarity of triangles and other planar figures;
- recognize, describe, and use elementary analytic geometry in problem solving, e.g. various measurements of planar geometric shapes in coordinate systems;
- recognize, describe, and use transformational geometry in problem solving, e.g. rigid transformations, size transformation, and symmetry in plane;
- analyze written arguments on course-level mathematical content and problems; and
- compose written arguments on course-level mathematical content and problems.

**Department of Mathematics and Physics**

**MATH 2330  
Elementary Geometry**

**Adoption date: November 11, 2011.**

**COURSE DESCRIPTION**

Introduction to classical Euclidean Geometry. Postulates, congruency, similarity and classical constructions. Introduction to solid geometry and transformations in the plane. (Formerly MATH 3320).

**STUDENT LEARNING OUTCOMES**

Upon successful completion of the course, the student will be able to:

- recognize undefined geometric objects, like point or line, and define geometric objects like segment, ray, circle, media, altitude, or bisector and state basic properties of these;
- use different criteria of congruency to determine congruent sides or angles in different triangles;
- use the Exterior Angle Theorem to deduce inequalities in triangles;
- construct using a compass and a rules a perpendicular to a line through a given point, a bisector to an angle, and a perpendicular bisector to a line;
- use properties of arcs in circles to deduce the measure of angles inscribed in circles, or construct tangent to circles;
- use Euclid's fifth postulate to deduce the measure of angles between parallel lines;
- recognize when two triangles are similar, and use this to prove theorems like Pythagora's Theorem, or to compute the length of segments in a given triangle;
- use isometries to deduce symmetries of geometrical objects, or construct geometrical objects with given properties.

## Department of Mathematics and Physics

### MATH 2412 Pre-Calculus

**Adoption date: January 24, 2014.**

#### **COURSE DESCRIPTION**

Topics include: Analytic geometry, complex numbers, and systems of algebraic equations; algebraic, exponential, logarithmic and trigonometric functions and applications; sequences and applications. Students will receive credits for at most two courses from MATH 1314, 1316 and 2412. Prerequisite: A COMPASS score of College Algebra 35 or above, a THEA Mathematics score of 280 or above, an ACT Mathematics score of 25 or above, an SAT Mathematics score of 600 or above, or MATH 1314..

#### **STUDENT LEARNING OUTCOMES**

Upon successful completion of this course, the student will be able to:

- set up, solve, and sketch the graphs of polynomial, rational, radical, exponential, and logarithmic equations and inequalities of one variable, and systems of linear and non-linear equations with two or more variables;
- perform operations with complex numbers and matrices to apply them to solve problems. Use the Polar form and D'Moivre's formula to compute the n-th root of a complex number;
- compute the general term of an arithmetic and geometric sequence and the sum of its terms, and perform the expansion of a positive integer power of a binomial;
- identify functions from algebraic, graphical, tabular, and verbal expressions and apply them to solve problems;
- recall the definition of the six basic trigonometric functions: sine, cosine, tangent, cotangent, secant, cosecant, as well as their basic periodicity properties, graphs and symmetries, and identify and use their inverse trigonometric functions, together with their domains and graphs, to solve trigonometric equations;
- verify trigonometric identities and their relative relationships, such as use the value of the trigonometric function of an angle to compute the value of a trigonometric function of the same angle, or double that angle, or half that angle; and
- use vectors and trigonometry concepts to solve problems related to geometry using the sine and cosine laws, or to solve problems related to parametric equations or polar coordinates and physics.

## Department of Mathematics and Physics

### MATH 2413 Calculus I

**Adoption date: April 24, 2009.**

#### **COURSE DESCRIPTION**

Limits, continuity, differentiation, applications to optimization; integration and the Fundamental Theorem of Calculus. Prerequisite: One or more of an ACT Mathematics score of 29 or above, an SAT Mathematics score of 660 or above, a COMPASS score of College Algebra 60 or above and Trigonometry 51 or above, MATH 1316, or MATH 2412.

#### **STUDENT LEARNING OUTCOMES**

Upon successful completion of this course, the student will be able to:

- recognize the basic concepts of certain mathematical models and functions and their representation;
- find limits of functions and use limits theorems. Transform indeterminate form limits and apply L'Hopital's rule to evaluate indeterminate limits. Determine continuity of functions;
- differentiate and sketch graphs of various functions such as: polynomial and rational functions, trigonometric functions, exponential functions and logarithmic functions;
- apply derivation rules and theorems such as the chain rule to find derivatives of sums, products, quotients, and compositions of functions, and use the derivative to solving extrema problems;
- interpret integration geometrically and apply techniques of integration.

## Department of Mathematics and Physics

### MATH 2414 Calculus II

**Adoption date: April 24, 2009.**

#### **COURSE DESCRIPTION**

Techniques and applications of integration: area between curves, volumes of solids of revolution, work, areas of surfaces of revolution, arc-length, introduction to differential equations, parametric equations and polar coordinates, sequences and series. Prerequisite: MATH 2413.

#### **STUDENT LEARNING OUTCOMES**

Upon successful completion of this course, the student will be able to:

- interpret the definite integral of a function geometrically as the area of a region, and use the Fundamental Theorem of Calculus to compute antiderivatives and definite integrals;
- apply different methods of integration, such as substitution, integration by parts, trigonometric integrals and partial fraction decomposition to compute antiderivatives as well as definite integrals;
- set up and compute integrals to solve problems in the computation of areas, volumes, work, arc-length, surface area of a surface of revolution, as well as be able to solve first order differential equations of linear and separable type, and be able to determine if a given improper integral converges;
- use a method of numerical integration to approximate a definite integral using several methods of approximation, including the left point, right point, trapezoid and Simpson's rule. Students will also be able to estimate the error in the computation of such approximations;
- identify curves given in terms of parametric equations, as well as write a curve in terms of a parameter. Students will also be able to apply integration to compute areas enclosed by a parametric curve, as well as to find its arc-length or area of revolution around an axis;
- approximate a given real analytic function using Taylor or Maclaurin series, be able to estimate the error, including determining if such series converges to the function, and use these techniques to compute limits of functions, estimate definite integrals or approximate the value of a function at a point.

## Department of Mathematics and Physics

### MATH 2415 Calculus III

**Adoption date: April 24, 2009.**

#### **COURSE DESCRIPTION**

Vector operations in  $\mathbb{R}^2$ ,  $\mathbb{R}^3$ , lines, planes; vector-functions, space curves, curvature; multivariable calculus, optimization, Lagrange multipliers; multiple integrals; vector fields, theorems of Green, Gauss and Stokes. Prerequisite: MATH 2414.

#### **STUDENT LEARNING OUTCOMES**

Upon successful completion of this course, the student will be able to:

- use the concepts of continuity, differentiation, and integration of vector-valued functions to determine unit tangent and unit normal vectors in the process of modeling objects in three dimensions;
- compute the curvature and torsion of a curve in space;
- calculate and sketch level curves and level surfaces for functions of several variables and sketch the graphs of functions of two variables;
- compute limits, determine continuity, and compute partial derivatives of multivariable functions;
- use tangent planes, directional derivatives, gradients, the second partials test, and Lagrange multipliers to approximate functions and solve optimization problems;
- demonstrate techniques of computation of multiple integral and compute iterated integrals over planar regions involving change of coordinate systems;
- apply multiple integrals to solve problems involving area, volume, surface area, center of mass, and moments of inertia;
- compute line integrals and surface integrals by applying The Fundamental Theorem for line integrals, Green's theorem, Stoke's Theorem and the Divergence Theorem, and applying these techniques to solve application problems such as work problems.

## **Department of Mathematics and Physics**

### **MATH 3195 Seminar**

**Adoption date: January 24, 2014.**

#### **COURSE DESCRIPTION**

One-three semester hours. Seminar on various topics in mathematics. May be repeated for credit with departmental approval.

#### **STUDENT LEARNING OUTCOMES**

Upon successful completion of this course, the student will be able to:

- analyze and synthesize issues, topics, and information in a mathematics research field;
- effectively express herself/himself both orally and in writing using well-constructed mathematical arguments;
- integrate knowledge and ideas in a coherent and meaningful manner;
- locate and use information for conducting mathematical investigation and/or research; and
- work independently to conduct mathematical research or inquiry.



# Department of Mathematics and Physics

## MATH 3310

### Introduction to Linear Algebra

**Adoption date: April 24, 2009.**

#### **COURSE DESCRIPTION**

Introduction to linear transformations and matrices; vector spaces, vector operations. Prerequisite: MATH 2415.

#### **STUDENT LEARNING OUTCOMES**

Upon successful completion of this course, the student will be able to:

- sketch the sum, difference, and linear combinations of two or more given vectors, sketch a (two- or three dimensional) vector with given components, and compute the components of a vector given as an arrow in an affine space;
- write the parametric form and normal form of the equation of a line or of a plane and use them for problem solving;
- using the Gauss-Jordan Elimination method, solve a system of linear equations (namely find a parametric representation of the solution space) or find the dimension and bases of the subspace spanned by a set of vectors. In particular, compute the rank and nullity of a matrix and describe the kernel and range of a linear transformation;
- determine whether the product of two given matrices or the powers of a matrix are defined, or whether the inverse of a matrix exists, and when it is defined / exist, compute it and interpret it;
- describe the linear transformation defined by a given matrix with respect to given bases. Conversely, given a description of a linear transformation, compute its matrix with respect to given bases. In particular, given the matrix of a linear transformation with respect to a certain pair of bases, compute the matrix of that linear transformation with respect to another pair of bases (“change of basis”);
- compute the eigenvalues and eigenvectors of a matrix, and determine whether the matrix is diagonalizable; and
- perform the Gram-Schmidt process to orthogonalize a basis of a vector space, and use it to compute the orthogonal complement of a subspace or the orthogonal projection of a vector onto a subspace.

## Department of Mathematics and Physics

### MATH 3325 Geometry

**Adoption date: November 19, 2010.**

#### **COURSE DESCRIPTION**

Selected topics from the foundations of Euclidean and non-Euclidean geometries. Includes the study of spherical and hyperbolic geometries, as well as transformational geometry, with techniques from linear algebra. Intended primarily for students seeking secondary certification.

#### **STUDENT LEARNING OUTCOMES**

Upon successful completion of the course, the student will be able to:

- distinguish between defined and undefined terms, and define geometric objects such as segment, ray, triangle, angle;
- recognize, distinguish, and describe the relationships between the theorems of neutral, Euclidean, and hyperbolic geometries;
- reason inductively and deductively with the models of Euclidean, Hyperbolic and Elliptic geometries;
- describe the classification of Euclidean transformations;
- perform and prove basic neutral and Euclidean constructions; and
- use basic theorems such as The Crossbar Theorem, and the Saccheri-Legendre Theorem to solve problems in Geometry.

## Department of Mathematics and Physics

### MATH 3330 Ordinary Differential Equations

**Adoption date: November 19, 2010.**

#### **COURSE DESCRIPTION**

Solution of first order differential equations. Study of second and higher order equations with constant coefficients. Power series solutions. Laplace Transform and Linear Systems. A brief introduction to numerical methods. Prerequisite: MATH 2415 and MATH 3310.

#### **STUDENT LEARNING OUTCOMES**

Upon successful completion of the course, the student will be able to:

- solve first order differential equations of separable, exact and linear type;
- use methods such as variation of parameters to solve linear differential equations of second or higher order with constant coefficients;
- use the Laplace transform to solve initial value problems;
- use power series to solve linear differential equations with analytic coefficients;
- use the eigenvalues and eigenvectors of a matrix to solve systems of differential equations with constant coefficients;
- approximate the solution of a differential equation using a numerical technique such as Euler's method; and
- apply differential equations to solve problems in Physics, Engineering, or Geometry.

## **Department of Mathematics and Physics**

### **MATH 3360 Statistical Analysis**

**Adoption date: November 19, 2010.**

#### **COURSE DESCRIPTION**

Fundamentals of probability, distribution theory, random variables, law of large numbers, central limit theorems, statistical inequalities. Prerequisite: MATH 2414.

#### **STUDENT LEARNING OUTCOMES**

Upon successful completion of the course, the student will be able to:

- compute and interpret measures of location and dispersion, and to calculate probabilities of events;
- describe methods of sampling and construct a sampling distribution;
- construct and interpret confidence and prediction intervals for a dependent variable;
- describe and carryout the five-step hypothesis-testing procedure; and
- describe the relationship between several independent variables and a dependent variable using regression analysis.

## Department of Mathematics and Physics

### MATH 3365 Discrete Mathematics

**Adoption date: November 19, 2010.**

**Updated and approved: February 3, 2011.**

#### **COURSE DESCRIPTION**

This course is a study of elements of discrete mathematics. Topics covered: logic; counting techniques; mathematical induction; the binomial theorem; number theory; set, relations and functions.

Prerequisite: MATH 2413.

#### **STUDENT LEARNING OUTCOMES**

Upon successful completion of the course, the student will be able to:

- discern the validity of logical statements; examine the logic of predicate and quantified statements; recognize whether an argument is valid or not; explain the logic and various methods of mathematical proofs and recognize when a proof is complete;
- generate numerous proofs using appropriate techniques including direct, indirect, counter example and the method of mathematical induction;
- work with and use sequences to solve discrete mathematics problems, e.g., identify arithmetic and geometric sequences and find a formula for the  $n$ th term of a sequence;
- solve problems in elementary set theory and formulate properties of sets through proof and counterexample;
- explain and solve problems involving counting using appropriate methods and techniques;
- analyze relations and determine if a given relation has certain properties, e.g. whether it is reflexive, transitive, symmetric, or anti-symmetric; and
- analyze functions and composite functions, and determine if a given function has certain properties, e.g. whether it is injective, surjective, or bijective.

## Department of Mathematics and Physics

### MATH 3371 Communication in Mathematics

**Adoption date: April 24, 2009.**

#### **COURSE DESCRIPTION**

This course is designated to enhance students' communication skills in mathematics. Emphasis will be placed in writing proofs. Topics include set theory, logic and properties of numbers at an elementary level. Substantial writing in mathematics using LaTeX is required. Prerequisite: ENGL 1302.

#### **STUDENT LEARNING OUTCOMES**

Upon successful completion of this course, the student will be able to:

- communicate mathematics in well-structured sentences, as well as in oral form;
- explain ethical responsibilities for the major of their choice;
- write mathematical statements in symbols and interpret mathematical symbols into plain English;
- analyze the structure of proofs such as direct and indirect proof, proof by contradiction, proof by cases, proof of equivalences;
- perform operations on sets and apply them to prove mathematical statements;
- perform operations on logical formulas and apply them to prove mathematical statements;
- analyze properties of integers, perform operations of numbers, and apply number theory to prove mathematical statements.

---

For your information: the following agreement was reached and stated in the 2008 AIER report

In regards to the outcome on “written paper assignment”, students will be asked to attend the writing center, prior to turning any paper to receive feedback on their writings at a non-technical level; faculty may revise and adapt the rubric to take into account that these papers are being written by sophomores and not graduating seniors, to adjust to a different level of expectation; possibly a different benchmark may be used to account for what is satisfactory writing at this level; and finally, students will be given the opportunity to write several versions of their paper before it is evaluated by the Assessment Committee. The idea in this case is that students will be able to revise their paper and learn from the comments given by the instructor, as they improve their writing skills in this course.

In regards to the outcome on “Ethics Writing Assignment”, students will be provided with a sample paper on ethics that relates to their major and will be asked to research for another one related to their major, and report on these papers. We believe this will work better because students in that course that reported on ethics in their major obtained an “A” when a sample paper was provided.

In regards to the outcome on “Oral Presentation”, students will be given an opportunity to practice their presentations in front of their peers and faculty member teaching MATH 2371, who will provide feedback. Students will also receive a guideline for giving presentations, as well as a copy of the rubric to be used to evaluate their presentation.

# Department of Mathematics and Physics

## MATH 3390 Principles of Math for Elem Ed

**Adoption date: January 24, 2014.**

### **COURSE DESCRIPTION**

An in-depth study of the mathematical principles and concepts underlying the traditionally computational techniques for the teaching of mathematics at early childhood and elementary school levels. The course content includes problem solving; arithmetic, algebra, geometry, probability, logic, counting, numeration and number systems (including natural, integer, rational, and real number systems), and their historical development; content based teaching; integrating various areas of mathematics; and examining connections of college-level mathematics course contents with the mathematics content of and its effective teaching at the early childhood and elementary school levels. Students must earn a “C” or better to successfully complete the course. The course may not be counted toward a major or minor in Mathematics or for certification in secondary mathematics. Open only to early childhood/elementary education majors. Prerequisite: Completion of Block I and a grade of at least “C” in MATH 1351. It is strongly recommended to take this course concurrently with Block II.

### **STUDENT LEARNING OUTCOMES**

Upon successful completion of the course, the student will be able to:

- analyze, design and appraise mathematics lesson plans for early childhood and elementary school mathematics;
- recognize, interpret, relate, propose and assess the appropriateness of application of various pedagogical knowledge and the mathematical content of early childhood and elementary school mathematics;
- recognize and appraise the connection between early childhood and elementary school mathematics content with the mathematics content of college level courses, e.g., through in-class lessons involving both elementary and post-secondary content;
- analyze and appraise mathematics from the historical perspectives, e.g., number and numeration systems through the ages;
- recognize, interpret and appraise mathematics contributions from various regions, cultures and societies from ancient recorded history to present;
- recognize, analyze and appraise connections between historical development of mathematical content/concepts and the learning of mathematics by an individual;
- analyze written arguments on mathematical content and pedagogy issues, problems and theorems; and
- compose written arguments on mathematical content and pedagogy issues, problems and theorems.

## **Department of Mathematics and Physics**

### **MATH 4305 Number Theory**

**Adoption date: November 19, 2010.**

#### **COURSE DESCRIPTION**

Divisibility, congruence, power residues, quadratic reciprocity, Diophantine equations, Euler's function, Fermat's theorem, primitive roots, Legendre and Jacobi symbols. Prerequisites: MATH 3365 and MATH 3310.

#### **STUDENT LEARNING OUTCOMES**

Upon successful completion of the course, the student will be able to:

- determine the solvability of linear, quadratic, and simultaneous congruences;
- determine the solvability of and solve basic Diophantine equations;
- calculate Legendre and Jacobi symbols efficiently;
- test primality probabilistically with the Fermat test; and
- conduct proofs using induction, divisibility, and other techniques.



# Department of Mathematics and Physics

## MATH 4310 Abstract Algebra I

**Adoption date: September 28, 2012**

### **COURSE DESCRIPTION**

Introduction to abstract algebra. Topics include Introduction to Ring theory: arithmetic in integers, modular arithmetic, fields, arithmetic in the Ring of polynomials. Unique factorization in integers and polynomials. Introduction to Group theory: definition and examples, subgroups, quotient groups, symmetry groups and permutation groups. Prerequisite: MATH 3365.

### **STUDENT LEARNING OUTCOMES**

Upon successful completion of this course, the student will be able to:

- explain and provide examples of the following terms: groups, rings, and fields;
- apply congruence relations in integer arithmetic;
- apply the extended Euclidean Algorithm to represent the greatest common divisor of two integers as a linear combination of them;
- determine if a binary operation on a set is a group operation and justify why or why not;
- compute the decomposition of a permutation and apply this information to solve other problems involving permutation groups;
- determine if a ring is an integral domain or even a field;
- compute the ideals of a ring and the corresponding quotient rings; and
- do arithmetic in a polynomial ring.

## Department of Mathematics and Physics

### MATH 4315 Abstract Algebra II

**Adoption date: April 24, 2009.**

#### **COURSE DESCRIPTION**

Continuation of MATH 4310. Topics in group theory: group actions, Sylow theorems, fundamental theorem of Abelian groups, and finite simple groups. Topics in Ring theory: ideals and quotient rings, Euclidean domain, principal ideal domain and unique factorization domain. Topics in Field theory: vector spaces, field extensions, finite field, and Galois theory. Prerequisite: MATH 4310.

#### **STUDENT LEARNING OUTCOMES**

Upon successful completion of this course, the student will be able to:

- recognize and describe various examples of groups, including groups of numbers, permutations, matrices, and transformations. Students will also be able to recognize and describe examples of subgroups and quotient groups of such groups, and examples of homomorphisms and isomorphisms between them;
- derive basic properties of groups, subgroups, quotient groups, homomorphisms, and isomorphisms from their definitions;
- recognize and describe various examples of rings, and as special cases of rings, of integral domains and fields. Students will also be able to recognize and describe examples of subrings, ideals, and quotient rings of such rings, and examples of homomorphisms and isomorphisms between them;
- derive basic properties of rings, integral domains and fields from their definitions.
- discuss and prove the unique factorization property of the ring of polynomials over a field, and perform related operations on polynomials such as Euclidean algorithm, irreducibility tests and factorization;
- recognize and describe the process of construction of field extensions. In particular, students will be able to construct (i) the field extension obtained by adjoining elements to the base field, and (ii) the splitting field of a polynomial over the base field; and
- describe the intermediate fields of a given field extension, and in the case of Galois extension, be able to describe the Galois group and Galois correspondence.

## **Department of Mathematics and Physics**

### **MATH 4330 Numerical Linear Algebra**

**Adoption date: November 19, 2010.**

#### **COURSE DESCRIPTION**

Numerical methods for problems of linear algebra, including the solution of large systems, eigenvalues and eigenvectors. Prerequisite: MATH 3310.

#### **STUDENT LEARNING OUTCOMES**

Upon successful completion of the course, the student will be able to:

- use the computer to solve large systems of linear equations by using iterative and elimination methods;
- solve least square and eigenvalue problems;
- compute singular value decomposition of matrices, QR factorization, Gram-Schmidt orthogonalization process, and Householder triangularization of matrices;
- apply theories about conditioning, stability, and accuracy to analyze simple numerical algorithms; and
- determine conditioning and stability of some classical algorithms, such as, the least square, Gaussian Elimination and the QR algorithms.

## Department of Mathematics and Physics

### MATH 4335 Advanced Calculus

**Adoption date: April 24, 2009.**

#### **COURSE DESCRIPTION**

A course in real analysis. It will include topology, continuity, differentiation, integration, sequences, series and power series. Prerequisite: MATH 2415.

#### **STUDENT LEARNING OUTCOMES**

Upon successful completion of this course, the student will be able to:

- describe the usual topology, including completeness, of the set of real numbers, including compact sets using the Heine-Borel Theorem;
- use the Bolzano-Weierstrass Theorem to determine the convergence of a sequence;
- determine the convergence or divergence of a numerical sequence or series, and determine if a series converges absolutely or conditionally;
- determine the convergence (and uniform convergence) of a sequence or series of functions, including a Taylor series, the interval of convergence of a power series and the possible outcome of integrating or differentiating a series of functions term by term;
- determine the continuity of a function at a point, the continuity of a function in an interval and if a continuous function is uniformly continuous in an interval;
- use Theorems such as Rolle's Theorem, the Mean Value Theorem, the Intermediate Value Theorem, and the Inverse Function Theorem for functions of one variable to solve problems in Analysis;
- use the definition of the Riemann Integral to determine if a bounded function defined in a closed and bounded interval is integrable, and use the Fundamental Theorem of Calculus for integrable functions to compute derivatives or to compute a definite integral;
- use definitions and theorems to provide proofs related to topics in this course.

## **Department of Mathematics and Physics**

### **MATH 4340 Numerical Analysis I**

**Adoption date: November 19, 2010.**

#### **COURSE DESCRIPTION**

Error analysis, solutions of non-linear functions, systems of linear equations, eigenvalue problems, interpolation theory, numerical differentiation and integration, numerical methods for ordinary differential equations. Prerequisites: MATH 3330 and MATH 3310.

#### **STUDENT LEARNING OUTCOMES**

Upon successful completion of the course, the student will be able to:

- demonstrate factual knowledge in the theoretical and practical aspects of the use of numerical methods;
- apply course material along with techniques and procedures covered in this course to solve problems, including nonlinear equations, systems of linear equations, eigenvalue problems, interpolation theory, numerical differentiation and integration, and numerical methods for ODEs;
- implement numerical methods for a variety of problems by using software packages such as Matlab;
- establish the limitations, advantages, and disadvantages of numerical methods; and
- determine numerical methods for a variety of applications.

## Department of Mathematics and Physics

### MATH 4345 Complex Variables

**Adoption date: November 19, 2010.**

#### **COURSE DESCRIPTION**

This is a course in complex variables which will include analytic functions, power series, the theory of residues and conformal mappings. Prerequisite: MATH 4335 or permission of instructor.

#### **STUDENT LEARNING OUTCOMES**

Upon successful completion of the course, the student will be able to:

- use the algebra, geometry and topology of complex numbers in problem solving;
- analyze and geometrically describe basic complex mappings including linear, reciprocal, Mobius transformations, power, root, exponential and logarithmic mappings;
- use the Cauchy-Riemann equations to prove that a function is analytic;
- use theorems like the Maximum Principle and Liouville's Theorem in problem solving;
- analyze and describe the local properties of complex analytic or meromorphic mappings at regular points (conformality), at branch points, and at singularities (poles);
- use properties of and operations on power (Taylor) series and Laurent series to analyze the properties of analytic or meromorphic functions; and
- use Cauchy's Theorem, Cauchy's Integral Formula, and the Residue Theorem to evaluate complex and real definite integrals.

## **Department of Mathematics and Physics**

### **MATH 4352 Internship in Mathematics**

**Adoption date: November 19, 2010.**

#### **COURSE DESCRIPTION**

A directed internship in a public/private organization that is appropriate to the student's career objective or desire in a mathematical science setting. Students will apply mathematical knowledge in a real world setting and receive on-the-job training experience. Seminar and training will be held to discuss field experience from theoretical and applied perspectives. Prerequisites: Permission of the instructor and advisor.

#### **STUDENT LEARNING OUTCOMES**

Upon successful completion of the course, the student will be able to:

- Apply professional judgment in the work environment
- Demonstrate an understanding of the legal, professional, and ethical issues in mathematics
- Identify, analyze and solve mathematical problems
- Prepare and submit progress reports
- Prepare and submit a final project report
- Deliver oral presentations with appropriate audio-visual materials

# Department of Mathematics and Physics

## MATH 4360 General Topology

**Adoption date: April 24, 2009.**

### COURSE DESCRIPTION

Basic concepts of point-set topology including connectedness, compactness, etc. and metric spaces.  
Prerequisite: MATH 4335 or permission of the instructor.

### STUDENT LEARNING OUTCOMES

Upon successful completion of this course, the student will be able to:

- recall and recognize similarities and differences between Metric Spaces and Topological Spaces;
- construct a Topology in a space using different tools and operations, e.g. closure, basis and sub-basis;
- classify Topological Spaces according to properties such as being compact, connected, normal, Hausdorff, etc.;
- construct new Topological Spaces from old ones such as constructing quotient spaces, product spaces or subspaces;
- recognize and construct continuous mappings from one Topological Space to another;
- determine if two different Topological Spaces are homeomorphic.

---

The following agreement was reached about outcomes for this course

- the course will be renamed to “Introduction to Topology”;
- the sentence “or permission of the instructor” will be removed from the prerequisites;
- the course description will be changed to  
Basic concepts of point-set topology including connectedness, compactness, etc. and metric spaces.  
*Additional topics such as the fundamental group may be included.* Prerequisite: MATH 4335;
- it is proposed to add MATH 3365 as a prerequisite to MATH 4335.

Instructors can add optional outcomes to this course, in case that they decide to include additional topics, as explained in the course description. Additional outcomes can only refer to the optional topic. In this case, instructors must submit their outcomes for the approval of the Department prior to inclusion in the syllabus, unless they have already been approved. Examples of outcomes approved by the Department are:

- recall and recognize homotopy, path homotopy, and the fundamental group of a Topological Space;
- construct an homomorphism between fundamental groups corresponding to a given homeomorphism between topological spaces.



## Department of Mathematics and Physics

### MATH 4365 Geometry of Curves and Surfaces

**Adoption date: November 19, 2010.**

#### **COURSE DESCRIPTION**

This course will present geometry of curves and surfaces in three dimensional Euclidean space. Topics include 1) From Curve Theory: Parametrized Curves, Arc Length, Frenet-Serret Frame, Singularities, Theory of Contact, Curvature, Torsion, Intrinsic Equation of Curves, Global Properties of Curves; 2) From Surface Theory: Parametrized Surfaces, Tangent Plane and Normal Line, First and Second Fundamental Forms, Curvature of Surfaces. Prerequisite: MATH 2415, 3310.

#### **STUDENT LEARNING OUTCOMES**

Upon successful completion of the course, the student will be able to:

- compute, describe, and interpret the curvature, torsion, Frenet-Serret frame, osculating circle, and osculating plane of a regular curve;
- analyze and classify regular plane and space curves;
- compute and interpret the total curvature of a regular curve;
- analyze and describe simple irregular points (cusps) of a curve;
- compute the first fundamental form of a surface and use it to analyze curves on the surface, such as the geodesics, and to compute the surface area;
- compute the second fundamental form of a surface, as well as principal, Gaussian, and mean curvatures, and use them to analyze the surface;
- analyze and describe examples of special classes of surfaces, such as ruled surfaces, minimal surfaces, and surfaces of constant curvature; and
- analyze and describe examples of isometries between surfaces.

## **Department of Mathematics and Physics**

### **MATH 4385 History of Mathematics**

**Adoption date: November 19, 2010.**

#### **COURSE DESCRIPTION**

Topics from arithmetic and computation, algebra, geometry, trigonometry, calculus, number theory, linear algebra, etc. from ancient recorded history to modern times intertwined with historical perspectives, biographies of several mathematicians from different cultures and times, their contributions, and that of their cultures, to mathematics and society. Prerequisite: Nine semester hours of advanced mathematics.

#### **STUDENT LEARNING OUTCOMES**

Upon successful completion of the course, the student will be able to:

- analyze and appraise mathematics from the historical perspectives, e.g. number and numeration systems through the ages;
- recognize, interpret, and appraise mathematics contributions from various regions, cultures, and societies from ancient recorded history to present;
- recognize, analyze and appraise connections between historical development of mathematical content/concepts and the learning of mathematics by an individual;
- analyze written proof to introductory to intermediate-level problems and theorems both in a historical and contemporary settings; and
- compose written proof to introductory to intermediate-level problems and theorems both in a historical and contemporary setting.

## **Department of Mathematics and Physics**

### **MATH 4390**

#### **Mathematics in the Middle and High Schools**

**Adoption date: April 24, 2009.**

#### **COURSE DESCRIPTION**

Explore contemporary issues, connections among various mathematics topics, and specialized pedagogical content knowledge for teaching mathematics at the secondary school level. Content topics may include: using sequences and series to solve problems in the mathematics of finance, relate geometry and algebra by representing transformations as matrices, apply probability concepts to make inferences in statistics, and essential understandings of functions in both higher-level mathematics and in real-world contexts, among others.

Prerequisite: Completion of Block I and at least twelve upper-level mathematic SCH. Concurrent enrollment in Block II is strongly recommended.

#### **STUDENT LEARNING OUTCOMES**

Upon successful completion of this course, the student will be able to:

- explain the connection among various mathematics topics and their applications,
  - solve problems using a variety of methods, including the use of technology,
  - apply mathematical reasoning and critical thinking skills to solve a variety of problems,
  - recognize various mathematical instructional strategies, and
  - assess student understanding, common misconceptions and error patterns in mathematics.
- 

#### **For your information: the following agreement was reached and stated in the 2008 AIER report**

In regards to the results of the TExES exam, we believe that students should have some familiarity with the exam before they take it for the first time. Because of this, activities will be added to the course “MATH 4390 Mathematics in the Middle and High School” (a capstone course for students in this degree), that will help students prepare for this exam.

## **Department of Mathematics and Physics**

### **MATH 4395 Senior Mathematics Project**

**Adoption date: April 24, 2009.**

#### **COURSE DESCRIPTION**

A study project under the direction of a member of the mathematics faculty. Required will be a written report, oral presentation and approval by both the advisor and one additional mathematics faculty member. Prerequisites: Senior standing and permission of instructor.

#### **STUDENT LEARNING OUTCOMES**

Upon successful completion of this course, the student will be able to:

- develop mathematical curiosity and use inductive and deductive reasoning to identify, analyze, and solve Mathematical problems
- understand and be able to use the language, symbols and notation of Mathematics to develop problem insight using available technology in Mathematics
- develop abstract, logical and critical thinking and the ability to reflect critically upon the work and the work of others
- develop the knowledge, skills and attitudes necessary to pursue further studies in Mathematics
- prepare and submit progress reports and a final project report
- deliver oral presentations with appropriate audio-visual materials

## **Department of Mathematics and Physics**

### **MATH 5191 Mathematics Seminar**

**Adoption date: November 19, 2010.**

#### **COURSE DESCRIPTION**

A seminar presents diverse topics from pure and applied mathematics. Students are encouraged to present a series of articles, journals and portions of monographs during the class meetings. May be repeated once when topics vary. Prerequisites: Graduate standing and permission of instructor. (Formerly MATH 5190)

#### **STUDENT LEARNING OUTCOMES**

Upon successful completion of the course, the student will be able to:

- effectively express themselves both orally and in writing using well constructed mathematical arguments;
- demonstrate the ability to integrate knowledge and ideas in a coherent and meaningful manner;
- demonstrate the ability to locate and use information for conducting mathematical investigation and/or research;
- demonstrate the ability to work independently towards conducting mathematical research or inquiry; and
- apply the mathematical sciences in other academic disciplines.

# **Department of Mathematics and Physics**

## **MATH 5290 Research Methods in Mathematics**

**Adoption date: November 19, 2010.**

### **COURSE DESCRIPTION**

This course deals with the basic tools of the mathematics to better understand mathematical research. Analytical concepts, survey research, in some cases, statistical/computational software and their methods will be the basis of this course. Prerequisites: Graduate standing and permission of the instructor.

### **STUDENT LEARNING OUTCOMES**

Upon successful completion of the course, the student will be able to:

- recall a variety of mathematical research methods in pure and applied mathematics, and how they have been used to address particular research questions in different settings;
- recognize and evaluate different research designs and methodologies;
- develop research project proposals;
- work independently on research projects; and
- write and extended paper.

## Department of Mathematics and Physics

### MATH 5303 Number Theory I

**Adoption date: November 19, 2010.**

#### **COURSE DESCRIPTION**

This first course in number theory introduces algebraic number theory as well as the analytic methods. Topics include: Number fields, algebraic integers, ideals and units, ideal class groups, ramification theory, quadratic and cyclotomic fields, zeta-functions and L-series. Prerequisites: Graduate standing and permission of instructor.

#### **STUDENT LEARNING OUTCOMES**

Upon successful completion of the course, the student will be able to:

- compute Legendre and Jacobi symbols efficiently using Quadratic Reciprocity Law;
- identify the ring of integers in quadratic, cyclotomic, or other select number fields;
- compute the discriminant of quadratic, cyclotomic, or other select number fields, and apply it to find the set of ramified primes;
- compute the prime decomposition in quadratic, cyclotomic, or select number fields, by Kummer's Theorem;
- compute the ideal class group and number of quadratic number fields using the Minkowski constant;
- compute the rank of the unit group of any number field using the Dirichlet's Unit Theorem, and compute the fundamental units of select real quadratic number fields; and
- identify the Dedekind zeta-function of any number field and compute it in select number fields.

## Department of Mathematics and Physics

### MATH 5305 Real Analysis I

**Adoption date: November 19, 2010.**

#### **COURSE DESCRIPTION**

This is a course on Lebesgue measure and integration. The classical  $L^p$  spaces will be defined and basic results established, such as the Holder and Minkowski inequalities and completeness of the spaces. Prerequisites: Graduate standing and permission of instructor.

#### **STUDENT LEARNING OUTCOMES**

Upon successful completion of the course, the student will be able to:

- explain the concepts of measurable sets, measurable function and measure;
- define the concept of Lebesgue Measure and Lebesgue Integral;
- explain the difference between the Lebesgue Integral and the Riemann Integral;
- distinguish between uniform convergence and pointwise convergence, and apply the Lebesgue dominated convergence theorem to prove convergence of integrals and the continuity of basic integral transforms, such as the Fourier Transform;
- explain the definition of  $L^p$  spaces, the Riesz representation theorem, and the completeness of the  $L^p$  spaces;
- explain the definition of the derivative of a measurable function; and
- explain how to construct measure theory in spaces other than the real line.



## Department of Mathematics and Physics

### MATH 5306 Linear Algebra

**Adoption date: November 19, 2010.**

#### **COURSE DESCRIPTION**

Topics include: Canonical structure theorems, diagonalization, the spectral theorem, inner-product spaces, and their applications and extensions. Prerequisite: Graduate standing and permission of instructor.

#### **STUDENT LEARNING OUTCOMES**

Upon successful completion of the course, the student will be able to:

- recognize, state, and use the definition of terminology, e.g. vector space, inner product space;
- recognize, distinguish and classify linear algebraic substructures, e.g. vector spaces, inner product spaces;
- analyze written proof to problems and theorems in Linear Algebra, e.g. spectral mapping theorem for linear transformations;
- compose written proof to problems and theorems in Linear Algebra, e.g. whether a linear operator is diagonalizable or not; and,
- demonstrate the ability to do independent learning and problem solving.

## Department of Mathematics and Physics

### MATH 5316 Graph Theory

**Adoption date: November 11, 2011.**

#### **Course Description**

This is a basic course in graph theory. Fundamental concepts of graph theory will be investigated. Topics include: directed graphs, trees and distance, spanning trees, coloring of graphs, planar graphs, edges and cycles. Prerequisites: Graduate standing and permission of instructor.

#### **STUDENT LEARNING OUTCOMES**

Upon successful completion of the course, the student will be able to:

- demonstrate knowledge of graph theoretic concepts such as simple graphs, digraphs, Eulerian and Hamiltonian graphs, trees (sorting and prefix codes), matchings, paths and cycles, graph colorings, planar graphs, isomorphism, walks, bipartite graph components, cut-edges, vertex degrees, and degree sequences;
- state the basic principles of structural graph theory and of graph minors including algorithmic applications on networks such as shortest path, minimal spanning tree, and mini-flow max-cut;
- apply a Hasse diagram to illustrate the relation among elements in a partially ordered set and a PERT diagram to prioritize tasks in executing a project;
- investigate matrix representation of graphs, including directed graphs, undirected graphs, connected components, and counting walks of a given length; and
- apply graph theory to solve classical problems, including minimum connector, marriage, assignment, network flow, committee scheduling, four color, and traveling salesman.

## Department of Mathematics and Physics

### MATH 5320 Complex Variables I

**Adoption date: November 19, 2010.**

#### **COURSE DESCRIPTION**

This is the first course on functions of one complex variable. It will begin with the complex number system and will treat topics such as power series, analytic functions, Mobius transformations, complex integrations, residue calculus, singularities, and Schwarz's Lemma. Prerequisite: Graduate standing and consent of instructor.

#### **STUDENT LEARNING OUTCOMES**

Upon successful completion of the course, the student will be able to:

- determine whether a complex function is differentiable and use the Cauchy-Riemann equations to calculate the derivative;
- determine whether a function is harmonic and find a harmonic conjugate via the Cauchy-Riemann equations;
- determine whether a complex series converges and find the region of convergence of a power series;
- find the Taylor or Laurent series for simple functions;
- use Cauchy's Integral Formula to evaluate contour integrals;
- use a Mobius Transformation to find a conformal mapping between two given regions; and
- identify and classify zeros and singular points of functions and use residues to evaluate various contour integrals.

## Department of Mathematics and Physics

### MATH 5330 Abstract Algebra I

**Adoption date: January 24, 2014.**

#### **COURSE DESCRIPTION**

This is the first course in Abstract Algebra. The main topics in this course will be groups, rings, fields, subgroups, quotient groups, ideals, homomorphisms and introduction to field extensions. There will be classical examples of permutation groups, polynomial rings and integral domains, questions of factorization, ideals and fundamental homomorphism theorems.

#### **STUDENT LEARNING OUTCOMES**

Upon successful completion of the course, the student will be able to:

- compute cyclic (sub)groups and their generators;
- classify certain small finite groups using Sylow's theorems;
- apply theoretical tools (e.g. the isomorphism theorems) to handle certain questions on concrete groups, such as dihedral groups, symmetric groups, abelian groups;
- apply the basic concepts of ring theory such as ideals by solving problems about concrete examples; and
- calculate the splitting field of certain polynomials.

## Department of Mathematics and Physics

### MATH 5350 Ordinary Differential Equations I

**Adoption date: November 19, 2010.**

#### **COURSE DESCRIPTION**

This is the first course in ordinary differential equations. The course will include systems of linear differential equations, two dimensional autonomous systems, existence, uniqueness and continuation of solutions, dependence of solutions on initial conditions and parameters. Prerequisites: Graduate standing and permission of instructor.

#### **STUDENT LEARNING OUTCOMES**

Upon successful completion of the course, the student will be able to:

- solve first-order nonlinear differential equation such as logistic population, constant harvesting, and periodic harvesting models (this includes exploration of a two-parameter family);
- apply the ideas of elementary differential equations to solve planar systems of differential equations with constant coefficients;
- plot phase portraits for planar systems;
- classify planar systems of differential equations; and
- solve higher-dimensional linear systems of differential equations; however, emphasis remains on three- and four-dimensional systems, though many of the techniques extend immediately to higher dimensions.

## **Department of Mathematics and Physics**

### **MATH 5355 Advanced Topics in Mathematics**

**Adoption date: November 19, 2010.**

#### **COURSE DESCRIPTION**

Advanced topics selected from the fields of pure or applied mathematics. May be repeated when topic changes. Prerequisites: Graduate standing and permission of instructor.

#### **STUDENT LEARNING OUTCOMES**

Upon successful completion of the course, the student will be able to:

- to demonstrate good knowledge of the core topics of the course,
- develop proper problem-solving skills at the course level, and
- have the foundations for more advanced mathematics or mathematics-related studies.
- explain a wide variety of the designated topics;
- carry out application and/or analysis on the topics;

# Department of Mathematics and Physics

## MATH 5360 Partial Differential Equations

**Adoption date: November 19, 2010.**

### **COURSE DESCRIPTION**

This is a basic course in partial differential equations. The course will cover the following: first order linear partial differential equations, classification of second order equations and canonical forms, Fourier series and integrals, the wave equation, the Cauchy problem for hyperbolic equations, the heat equation, the weak maximum principle, the strong maximum principle, the Laplace equation, Green's function and Poisson's formula. Prerequisite: Graduate standing and permission of instructor.

### **STUDENT LEARNING OUTCOMES**

Upon successful completion of the course, the student will be able to:

- explain clearly the mathematical formulation of stationary and time-dependent boundary value problems arising in physical problems and to derive equations with source in one and three-spatial dimensions for different physical models;
- solve boundary value problems involving partial differential equations, in particular the heat, wave and potential equations by using the method of separation of variables;
- apply Fourier series and integral transform techniques to obtain solutions of appropriate initial and boundary value problems;
- find D'Alembert's solution of the wave equation and the distributed-source solution of the heat equation; and
- classify the second order PDE by using the discriminant of the principal part as a hyperbolic, parabolic or elliptic equation, to interpret the geometrical and physical meanings of the classification, and how this classification is connected with patterns that the equation predicts.

## Department of Mathematics and Physics

### MATH 5365 Topology

**Adoption date: November 11, 2011.**

#### **COURSE DESCRIPTION**

This is an introductory course in point-set topology. The course will include topological spaces, continuous functions, connectedness, separation axioms. Tychonoff's theorems, para- compactness, complete metric spaces and function spaces will also be discussed. Prerequisite: Graduate standing and permission of instructor.

#### **STUDENT LEARNING OUTCOMES**

Upon successful completion of this course, the student will be able to:

- prove the equivalence between the topological and epsilon-delta definition of limit and continuity in metrizable spaces;
- construct new topological spaces, such as constructing quotient spaces, product spaces or subspaces, from old ones;
- apply concepts such as connectivity, compactness, and dimension theory to topologically distinguish between non-homeomorphic pairs of spaces that naturally arise from geometry;
- determine, for both the uniform and pointwise convergence topologies, whether the space of continuous functions between two naturally arising metric spaces is metrizable and whether it is completely metrizable; and
- apply the axiom of choice or its equivalents to solve problems that arise in its application to other areas of mathematics.



# Department of Mathematics and Physics

## MATH 5367 Numerical Methods for PDE I

**Adoption date: January 24, 2014.**

### **COURSE DESCRIPTION**

A study of algorithms for the numerical solution of hyperbolic and parabolic partial differential equations using the finite difference method; stability and convergence of methods and error bounds. Applications from physics and engineering will be emphasized.

### **STUDENT LEARNING OUTCOMES**

Upon successful completion of this course, the student will be able to:

- identify appropriate numerical solution procedures for a given PDE;
- derive and implement finite difference schemes for hyperbolic and parabolic PDEs;
- apply the finite element method to elliptic PDEs;
- analyze stability and convergence properties of numerical schemes; and
- identify the potential sources of error in numerical methods for PDEs.

## **Department of Mathematics and Physics**

### **MATH 5370 Mathematical Modeling**

**Adoption date: November 19, 2010.**

#### **COURSE DESCRIPTION**

This is the first course in mathematical modeling. Topics include: linear equations and models, non-linear equations and models, modeling with linear systems, modeling with non-linear systems, mathematical modeling and dynamical systems, non-homogeneous systems, empirical models and linear regression, bifurcation and chaos. Working knowledge of a computer programming language is preferred. Prerequisites: Graduate standing and permission of instructor.

#### **STUDENT LEARNING OUTCOMES**

Upon successful completion of the course, the student will be able to:

- determine a proper class of mathematical models for a problem and classify the variables;
- determine interrelationships among the variables selected in the problem;
- make and test conjectures;
- use real-world data to create a mathematical model; and
- solve the model problem to predict results based on the given data.

## **Department of Mathematics and Physics**

### **MATH 5395**

#### **Graduate Research in Mathematics**

**Adoption date: November 19, 2010.**

#### **COURSE DESCRIPTION**

Students work on a theoretical or applied research project. The plan of study is negotiated by the faculty member and the student. Course may be repeated under different topic for credit. Offer only "Pass/Fail" grades. Prerequisites: Consent of the instructor and the department.

#### **STUDENT LEARNING OUTCOMES**

Upon successful completion of the course, the student will be able to:

- express themselves both orally and in writing using well-constructed mathematical arguments;
- integrate knowledge and ideas in a coherent and meaningful manner;
- locate and use information for conducting mathematical investigation and/or research;
- work independently towards conducting mathematical research or inquiry;
- present the research problem and any results attained to a knowledgeable audience.

## Department of Mathematics and Physics

### MATH 5375 Probability

**Adoption date: April 24, 2009.**

#### **COURSE DESCRIPTION**

Topics include: distribution functions, random variables, expectation, independence, convergence concepts, law of large numbers, characteristic functions, the central limit theorem, conditional expectation, martingales and Brownian. Prerequisites: Graduate standing and permission of instructor.

#### **STUDENT LEARNING OUTCOMES**

Upon successful completion of this course, the student will be able to:

- interpret the main concepts and results in measure theory, define sample spaces, probability measure, and events, and compute probabilities of events;
- distinguish various modes of convergence ;
- explain concept of conditional probability and independent events, determine whether events are independent or not, and compute probabilities (joint and conditional) of two or more random variables;
- interpret and simulate law of large numbers, and apply central limit theorem to compute normal approximations to random variables;
- solve simple problems on martingales, stopping time, and Brownian motion.

## **Department of Mathematics and Physics**

### **MATH 5398**

#### **Thesis I**

**Adoption date: January 24, 2014.**

#### **COURSE DESCRIPTION**

To be scheduled by the student in consultation with his/her advisor. Prerequisite: Graduate standing and permission from the student's thesis advisory committee. Approval of the major professor and the department chair. All core courses should be completed prior to beginning thesis work preferably during the last year of the student's program of study. Evaluation of performance in this course is on CR/NC basis. If grade of IP is received, student must enroll again for credit.

#### **STUDENT LEARNING OUTCOMES**

Upon successful completion of the course, the student will be able to:

- efficiently search the mathematical literature for books and journal articles relevant to his/her thesis topic, including efficient use of the MathSciNet database and interlibrary loan;
- recognize, interpret, and appraise mathematical concepts needed in the study of a particular topic in mathematics;
- analyze written proof of introductory to advanced-level problems and theorems;
- summarize in written form the field's current state of knowledge regarding his/her thesis topic; and
- write a research proposal in a widely used mathematical journal format, such as AMS, SIMA, Springer, etc.

## **Department of Mathematics and Physics**

### **MATH 5399 Thesis II**

**Adoption date: November 19, 2010.**

#### **COURSE DESCRIPTION**

To be scheduled by the student in consultation with his/her advisor. Prerequisite: Graduate standing and permission from the student's thesis advisory committee. Approval of the major professor and the department chair. Evaluation of performance in this course is on CR/NC basis. A good standing in MATH 5398 Thesis I is required. If grade of IP is received, student must enroll again for credit.

#### **STUDENT LEARNING OUTCOMES**

Upon successful completion of the course, the student will be able to:

- demonstrate a knowledge of formal mathematical writing and presentation;
- demonstrate an ability of self study and research in mathematics;
- recognize, interpret, and appraise mathematical concepts needed in the study of a particular topic in mathematics;
- analyze written proof of introductory to advanced-level problems and theorems; and
- compose written proof to introductory to intermediate-level problems and theorems.

# **Department of Mathematics and Physics**

## **STAT 5300**

### **Categorical Data Analysis**

**Adoption date: Fall 2016.**

#### **COURSE DESCRIPTION**

In this course students will be exposed to statistically significant techniques beyond those of linear regression. Topics to be covered include the Generalized Likelihood Ratio test, theory of a generalized linear model, Poisson regression, logistic regression, and analysis of data on a more categorical basis among others.

#### **STUDENT LEARNING OUTCOMES**

Upon successful completion of the course, the student will be able to:

- Evaluate procedures for the analysis of categorical data.
- Use modern statistical software and a programming language.
- Judge effectively the results of various models in a statistical analysis.
- Demonstrate use of specialized statistical methods in the course.
- Use statistical and computational methods for economic and clinical data.

# Department of Mathematics and Physics

STAT 5305

## Applied Data Analysis

**Adoption date: Fall 2016.**

### **COURSE DESCRIPTION**

Concepts related to the theory and application of analysis of significance in data samples, probabilistic inference, expectation, hypothesis testing, and other statistical analysis methods.

### **STUDENT LEARNING OUTCOMES**

Upon successful completion of the course, the student will be able to:

- After completing the coursework of applied statistics courses, students should be able to:
- Solve and interpret measures of location and dispersion. Calculate probabilities of multiple random events.
- Describe methods of sampling and construct a sampling distribution.
- Construct and interpret confidence and prediction intervals for a dependent variable.
- Describe and carryout the five-step hypothesis-testing procedure.
- Contrast the relationship between several independent variables and a dependent variable using regression analysis.



**Department of Mathematics and Physics**  
**STAT 5306**

**Generalized Linear Models with Applications**

**Adoption date: Fall 2016.**

**COURSE DESCRIPTION**

In a broader statistical context, simple discrete statistical modeling does not suffice. To accommodate the analysis of mixed discrete and continuous models and other more general samples, this course implements generalized linear models. This is an extension on linear regression analysis.

**STUDENT LEARNING OUTCOMES**

Upon successful completion of the course, the student will be able to:

- Describe a cumulative multinomial generalized linear model, with applications to grouped doxological mortality data.
- Explain and apply the fundamentals of applied statistical methodology.
- Evaluate effectively the results of a statistical analysis.
- Demonstrate the use of multiple statistical software packages and use software.
- Use statistical and computational methods for economic and clinical data.

# **Department of Mathematics and Physics**

## **STAT 5310**

### **Statistical Methods for Clinical Trials**

**Adoption date: Fall 2016.**

#### **COURSE DESCRIPTION**

This course is designed around the design of data collection and analysis related to experiments conducted in a clinical setting. Approaches towards minimizing bias in sampling and category responses are emphasized.

#### **STUDENT LEARNING OUTCOMES**

Upon successful completion of the course, the student will be able to:

- Explain the fundamentals of central statistical monitoring in clinical trials.
- Use modern statistical software and a programming language.
- Evaluate effectively the results of a statistical experiment.
- Interpret the use of data collection in a statistical setting.
- Demonstrate the probabilistic foundations of inference applications.

# **Department of Mathematics and Physics**

**STAT 5322**

## **Theory of Sampling and Surveys**

**Adoption date: Fall 2016.**

### **COURSE DESCRIPTION**

This course will cover the theory and application of methods geared towards sample intake and survey conduct. Topics include simple random sampling, proportion estimates, regression estimation, cluster sampling, multistage design, and more.

### **STUDENT LEARNING OUTCOMES**

Upon successful completion of the course, the student will be able to:

- Design of sample surveys that include treatment of the various sampling methodologies used in population parameter estimation.
- Demonstrate proficiency in sampling using various methods.
- Evaluate effectively the results of a statistical analysis.
- Develop successfully a wide range of methodological statistics techniques.
- Use statistical and computational methods for economic and clinical data.

# Department of Mathematics and Physics

STAT 5327

## Computational Methods in Statistics

**Adoption date: Fall 2016.**

### **COURSE DESCRIPTION**

This course will focus on statistically significant computing methods, such as the R programming language, and the implementation of models relevant to such studies.

### **STUDENT LEARNING OUTCOMES**

Upon successful completion of the course, the student will be able to:

- Use computational methods in statistics to face complex problems and highly dimensional data, as well as the widespread availability of computer.
- Use modern statistical software and a programming language.
- Explain concepts and skills to solve problems that arise in other disciplines.
- Demonstrate use of programming in statistical description in the course.
- Describe the use of formal computational argument in the context of statistics.

# **Department of Mathematics and Physics**

## **STAT 5328**

### **Regression and Applied Time Series Models**

**Adoption date: Fall 2016.**

#### **COURSE DESCRIPTION**

This course focuses on the study of data correlated over a certain period of time. The correlation of such data can be analyzed using various tools including ARIMA models, suitability estimates, forecast predictions, smoothing methods, cross correlation, lagged regressions, use of time series variables, intervention analysis, longitudinal analysis, multivariate time series, and frequency domain analysis to name a few.

#### **STUDENT LEARNING OUTCOMES**

Upon successful completion of the course, the student will be able to:

- Appraise statistical methods for regression and time series analysis.
- Illustrate the ability to explore data by selecting methodologies for analysis.
- Evaluate effectively the results of a statistical analysis.
- Demonstrate linear regression with model fitting and forecasting.
- Use statistical and computational methods for economic and clinical data.

# **Department of Mathematics and Physics**

## **STAT 5329**

### **Analysis of Variance in Experimental Design Models**

**Adoption date: Fall 2016.**

#### **COURSE DESCRIPTION**

Experimental data can be correlated via an analysis of the variances related to the data, with a statistically significantly large enough sample. This course focuses on the use of ANOVA methodology to encourage proper model selection for statistical analysis in a laboratory setting.

#### **STUDENT LEARNING OUTCOMES**

Upon successful completion of the course, the student will be able to:

- Design an experimental study and carry out an appropriate statistical analysis of the data, and interpret and communicate the results.
- Discuss the fractional factorials, models with random effects, crossover designs, latin squares, split plot designs, repeated measures, and BIBD, power and sample size.
- Use modern statistical software and a programming language.
- Evaluate effectively the results of a statistical analysis.
- Use statistical and computational methods for economic and clinical data.

# **Department of Mathematics and Physics**

## **STAT 5340**

### **Quality Control and Improvement**

**Adoption date: Fall 2016.**

#### **COURSE DESCRIPTION**

This course is designed for the study of the theory and application of statistical methods in order to assess the integrity of statistically analyzable processes (like mass production). Methods to increase quality management and productivity while considering variables, attributes, various analysis methodologies, sampling, graphing, model selection, and others will be studied.

#### **STUDENT LEARNING OUTCOMES**

Upon successful completion of the course, the student will be able to:

- Describe the basic process of quality control and improvement in an industry.
- Use modern statistical software and a programming language as needed.
- Evaluate effectively the results of a statistical analysis.
- Demonstrate specialized statistical methods in the course.
- Use statistical and computational methods for economic and clinical data.

# Department of Mathematics and Physics

STAT 5341

## Applied Multivariate Analysis

**Adoption date: Fall 2016.**

### **COURSE DESCRIPTION**

This course covers the study of more sparsely correlated data. Among the topics are the theory and application of advanced testing of correlations and analysis of varied aggregate data techniques such as cluster and discriminant analysis. Factor analysis is covered in detail, as is graphical display of multivariate data, sample correlations, inference, conditional distribution and partial correlation, principal component analysis, and multivariate analysis of variance.

### **STUDENT LEARNING OUTCOMES**

Upon successful completion of the course, the student will be able to:

- Discuss the topics in applied multivariate analysis including Hotelling's T-squared, multivariate ANOVA, discriminant functions, factor analysis, principal components mathematical basis and foundations.
- Use modern statistical software and a programming language.
- Evaluate effectively the results of multivariate analysis.
- Demonstrate use of specialized statistical methods in the course.
- Illustrate statistical and computational methods for economic data.



# **Department of Mathematics and Physics**

**STAT 5387**

## **Statistical Models for Spatial Data**

**Adoption date: Fall 2016.**

### **COURSE DESCRIPTION**

This course will cover the linear and general linear regression models with respect to smoothing and in the context of large correlated samples taken over multi-dimensional regions. Some programming experience is recommended for proper implementation of the models and samples to be discussed.

### **STUDENT LEARNING OUTCOMES**

Upon successful completion of the course, the student will be able to:

- Illustrate treatment of basic statistical theory for spatial data analysis.
- Interpret the proficient use of data analysis and consultancy in the course.
- Use modern statistical software and a programming language.
- Evaluate effectively the results of statistical models.
- Demonstrate proficiency using methods embedded in the courses.

# **Department of Mathematics and Physics**

## **STAT 5390**

### **Case Seminar in Applied Statistics**

**Adoption date: Fall 2016.**

#### **COURSE DESCRIPTION**

The student, guided by a chosen faculty member(s), will prepare a project related to statistics and applied mathematics. The student then presents the results in a seminar during the student's final semester that usually lasts 75 minutes followed by a short Q&A session. This replaces the comprehensive examination requirement. Students must exhibit a working knowledge of two useful computer languages or data analysis software packages.

#### **STUDENT LEARNING OUTCOMES**

Upon successful completion of the course, the student will be able to:

- Explain and apply the fundamentals of applied statistical methodology.
- Develop modern statistical software and a programming language as needed.
- Evaluate effectively the results of a statistical analysis in the course.
- Develop a final data analysis project, as required for the Master's Degree.
- Demonstrate proficiency in statistical analysis through a research presentation.

## **Department of Mathematics and Physics**

### **ASTR 1110 Principles of Astronomy Lab**

**Adoption date: Fall 2016, revised in Spring 2021**

#### **COURSE DESCRIPTION**

Laboratory course to accompany ASTR 1310. Practical exercises reinforce ASTR 1310 lecture material. Topics include unaided-eye observation, telescopic observation, telescope manipulation, and experiments/exercises. Must be taken concurrently with ASTR 1310. Carries no credit towards a major or minor in Physics. Lab fee: \$30.

#### **STUDENT LEARNING OUTCOMES**

Upon successful completion of the course, the student will be able to:

- describe the basic function of a telescope;
- use a telescope and other basic astronomical tools, such as a spectroscope;
- collect experimental data to compare with theoretical predictions;
- plot astronomical data to show relationships between variables in graphical form;
- interpret astronomical data from tables and graphs.

# Department of Mathematics and Physics

## ASTR 1310 Principles of Astronomy

**Adoption date: Fall 2016, revised in Spring 2021**

### **COURSE DESCRIPTION**

An introductory survey of the solar system to include astronomical history and instrumentation, the planets and their moons, comets, asteroids, and meteoroids. Designed to fulfill laboratory science core curriculum requirements. Must be taken concurrently with ASTR 1110. Carries no credit toward a major or minor in Physics.

### **STUDENT LEARNING OUTCOMES**

Upon successful completion of the course, the student will be able to:

- describe how scientists combine observation, theory, and testing in their study of the universe;
- describe how and why the Sun, the Moon, and the stars appear to change their positions from night to night and from month to month;
- explain the composition, History, and properties of the universe.
- discuss the nature of electromagnetic radiation and tell how that radiation transfers energy and information through interstellar space;
- develop a research project in a group or individual, and submit a written report that clearly explains the problem and the findings.

## **Department of Mathematics and Physics**

### **ASTR 1112 Stellar Astronomy Laboratory**

**Adoption date: November 19, 2010.**

#### **COURSE DESCRIPTION**

Laboratory course to accompany ASTR 1312. Practical exercises reinforce ASTR 1312 lecture material. Topics include unaided-eye observation, telescopic observation, telescope manipulation, and experiments/exercises. Must be taken concurrently with ASTR 1312. Carries no credit towards a major or minor in Physics. Lab fee: \$30.

#### **STUDENT LEARNING OUTCOMES**

Upon successful completion of the course, the student will be able to:

- describe the basic function of a telescope;
- correctly use a telescope and other basic astronomical tools, such as a spectroscope, to observe celestial objects;
- collect experimental data to compare with theoretical predictions;
- plot astronomical data to show relationships between variables in graphical form; and
- interpret astronomical data from tables and graphs.

## **Department of Mathematics and Physics**

### **ASTR 1312 Stellar Astronomy**

**Adoption date: November 19, 2010.**

#### **COURSE DESCRIPTION**

An introductory survey of stellar properties and life cycles, H-R Diagrams, as well as galaxies and Hubble's Law. Instrumentation techniques used to collect astronomical data is discussed in addition to topics from cosmology including General Relativity theory and the Big Bang theory. May be taken independently from ASTR 1311. Designed to fulfill laboratory science core curriculum requirements. Must be taken concurrently with ASTR 1112. Carries no credit towards a major or minor in Physics.

#### **STUDENT LEARNING OUTCOMES**

Upon successful completion of the course, the student will be able to:

- describe how scientists combine observation, theory, and experimentation in the study of the universe;
- explain why the Sun, the Moon, the planets, and the stars appear to change their positions in the sky from night to night and from month to month;
- describe the major contributions of Galileo, Kepler, and Newton to the development of our understanding of the solar system;
- discuss the nature of electromagnetic radiation and describe how radiation transfers energy and information through interstellar space; and
- summarize the life cycle of stars of different masses.

## **Department of Mathematics and Physics**

### **PHYS 1101 General Physics I Laboratory**

**Adoption date: April 24, 2009.**

#### **COURSE DESCRIPTION**

Laboratory course to accompany PHYS 1301. Laboratory exercises reinforce PHYS 1301 lecture material and place importance on scientific communication and collaboration as well as measurement methods, uncertainty and basic error analysis. Must be taken concurrently with PHYS 1301. Carries no credit towards a major or minor in physics. Lab fee: \$30.00.

#### **STUDENT LEARNING OUTCOMES**

Upon successful completion of the course, the student will be able to:

- define the basic physics principles in each experiment;
- set up and correctly operate the instruments;
- collect and process the experiment data;
- interpret the results, and identify the sources of the error;
- prepare and complete an experimental report.

## **Department of Mathematics and Physics**

### **PHYS 1301 General Physics I**

**Adoption date: April 24, 2009.**

#### **COURSE DESCRIPTION**

A non-calculus-based treatment of the fundamentals of classical mechanics, sound, fluid mechanics and heat. Topics include one and two dimensional motion, forces and Newton's Laws, momentum conservation, energy conservation, rotational dynamics, angular momentum, waves, simple harmonic motion, kinetic theory, calorimetry and thermodynamics. Designed to fulfill laboratory science core curriculum requirements. Prerequisite: MATH 1316 or equivalent. Must be taken concurrently with PHYS 1101. Carries no credit toward a major or minor in physics.

#### **STUDENT LEARNING OUTCOMES**

Upon successful completion of the course, the student will be able to:

- state Newton's three laws of motion, and apply it to solve physics problems;
- illustrate work-energy theorem and law of energy conservation, and apply them to solve physics problems;
- illustrate momentum conservation, and apply it to solve physics problems;
- interpret rotational motion, and apply it to solve physics problems;
- describe simple harmonic motion, and apply it to solve physics problems.



## **Department of Mathematics and Physics**

### **PHYS 1102 General Physics II Laboratory**

**Adoption date: November 19, 2010.**

#### **COURSE DESCRIPTION**

Laboratory course to accompany PHYS 1302. Laboratory exercises reinforce PHYS 1302 lecture material and place importance on scientific communication & collaboration as well as measurement methods, uncertainty and basic error analysis. Must be taken concurrently with PHYS 1302. Lab fee: \$30.00.

#### **STUDENT LEARNING OUTCOMES**

Upon successful completion of the course, the student will be able to:

- explain the basic physics principles in each experiment;
- set up and operate the instruments correctly;
- collect and process the experimental data;
- interpret the results, and identify the sources of the error; and
- prepare and complete an experimental report.

## **Department of Mathematics and Physics**

### **PHYS 1302 General Physics II**

**Adoption date: November 19, 2010.**

#### **COURSE DESCRIPTION**

Continuation of PHYS 1301. A non-calculus-based treatment of the fundamentals of electricity and magnetism, sound, light and modern physics. Topics include electrostatics, magnetostatics and magnetic materials, electromagnetic waves, geometric optics, physical optics, quantum mechanics, nuclear physics and relativity theory. Designed to fulfill laboratory science core curriculum requirements. Must be taken concurrently with PHYS 1102. Prerequisites: PHYS 1301/PHYS 1101. Carries no credit toward a major or minor in physics.

#### **STUDENT LEARNING OUTCOMES**

Upon successful completion of the course, the student will be able to:

- describe electric fields, electric potential and electric potential energy, and apply them to solve physics problems;
- illustrate Ohm's law and Kirchhoff's law, and apply them to solve DC circuits;
- describe magnetic forces and magnetic fields, and apply them to solve physics problems;
- illustrate electromagnetic induction, electromagnetic waves, and apply it to the solution of physics problems;
- state what an alternating current circuit is, and apply it to the solution of physics problems;
- describe the reflection and refraction of light, and apply them to the solution of physics problems; and
- explain interference and the wave nature of light, and apply them to solve physics problems.

## **Department of Mathematics and Physics**

### **PHYS 1170**

#### **Survey of Physical Science Laboratory**

**Adoption date: April 24, 2009.**

#### **COURSE DESCRIPTION**

Laboratory course to accompany PHYS 1370. Laboratory exercises reinforce PHYS 1370 lecture material and place importance on scientific communication and collaboration as well as measurement methods. Some mention is made of uncertainty and basic error analysis. Must be taken concurrently with PHYS 1370. Carries no credit towards a major or minor in physics. Lab fee: \$30.00.

#### **STUDENT LEARNING OUTCOMES**

Upon successful completion of the course, the student will be able to:

- define the basic physics principles in each experiment;
- set up and correctly operate the instruments;
- collect and process the experiment data;
- interpret the results, and identify the sources of the error;
- prepare and complete an experimental report.

## **Department of Mathematics and Physics**

### **PHYS 1370 Survey of Physical Science**

**Adoption date: November 19, 2010.**

#### **COURSE DESCRIPTION**

An introductory survey of physical science. Topics include physics (motion, forces, waves and thermodynamics), chemistry (periodic table, reactions), earth science (geology, weather, biosphere and environment) and astronomy (astronomical history, planetary astronomy, stellar astronomy and cosmology). Designed to fulfill laboratory science core curriculum requirements. Must be taken concurrently with PHYS 1170. Carries no credit towards a major or minor in physics.

#### **STUDENT LEARNING OUTCOMES**

Upon successful completion of the course, the student will be able to:

- describe Newton's three laws of motion and apply them to solve physics problems;
- explain mechanical energy and law of energy conservation, and apply them to solve physics problems;
- state the heat equation, the first and second laws of thermodynamics, and apply them to solve physics problems;
- outline wave and wave equations, and apply them to solve physics problems;
- state Ohm's law, describe power and electric energy and apply them to solve physics problems; and
- describe the properties of light, and the dual nature of light from the modern physics point of view.

## **Department of Mathematics and Physics**

### **PHYS 2125 University Physics I Laboratory**

**Adoption date: April 24, 2009.**

#### **COURSE DESCRIPTION**

Laboratory course to accompany PHYS 2325. Laboratory exercises reinforce PHYS 2325 lecture material and place importance on scientific communication and collaboration as well as measurement methods, uncertainty, and basic error analysis. Must be taken concurrently with PHYS 2325. Lab fee: \$30.00.

#### **STUDENT LEARNING OUTCOMES**

Upon successful completion of the course, the student will be able to:

- explain why experiments are an important component of the scientific method;
- explain why uncertainty is present in all measurements;
- collect experimental data to compare with theoretical predictions;
- plot data to show relationships between variables in graphical form;
- interpret data from tables and graphs.

## Department of Mathematics and Physics

### PHYS 2325 University Physics I

**Adoption date: April 24, 2009.**

#### **COURSE DESCRIPTION**

A calculus-based treatment of the fundamentals of classical mechanics, sound, fluid mechanics, and heat. Topics include one- and two-dimensional motion, forces and Newton's laws, momentum conservation, energy conservation, rotational dynamics, angular momentum, waves, simple harmonic motion, kinetic theory, calorimetry, and thermodynamics. Prerequisite: MATH 2413 or equivalent, or concurrent registration therein. Must be taken concurrently with PHYS 2125.

#### **STUDENT LEARNING OUTCOMES**

Upon successful completion of the course, the student will be able to:

- differentiate between a vector quantity and a scalar quantity;
- state Newton's three laws of motion and give everyday examples of each law;
- state the work-energy theorem and apply it to physics problems;
- state the law of conservation of energy and apply it to physics problems;
- state the law of conservation of momentum and apply it to physics problems.

## **Department of Mathematics and Physics**

### **PHYS 2126 University Physics II Laboratory**

**Adoption date: November 19, 2010.**

#### **COURSE DESCRIPTION**

Laboratory course to accompany PHYS 2326. Laboratory exercises reinforce PHYS 2326 lecture material and place importance on scientific communication and collaboration as well as measurement methods, uncertainty, and basic error analysis. Lab fee: \$30.00.

#### **STUDENT LEARNING OUTCOMES**

Upon successful completion of the course, the student will be able to:

- explain why experiments are an important component of the scientific method;
- explain why uncertainty is present in all measurements;
- collect experimental data to compare with theoretical predictions;
- plot data to show relationships between variables in graphical form;
- interpret data from tables and graphs; and
- prepare a physics laboratory report in proper format.

## Department of Mathematics and Physics

### PHYS 2326 University Physics II

**Adoption date: November 19, 2010.**

#### **COURSE DESCRIPTION**

A calculus-based treatment of the fundamentals of electricity and magnetism, sound, light, and modern physics. Topics include electrostatics, magnetostatics and magnetic materials, electromagnetic waves, geometric optics, physical optics, quantum mechanics, nuclear physics, and relativity theory. Must be taken concurrently with PHYS 2126. Prerequisites: MATH 2414 or equivalent (or concurrent enrollment therein) and PHYS 2325/PHYS 2125.

#### **STUDENT LEARNING OUTCOMES**

Upon successful completion of the course, the student will be able to:

- describe qualitatively and quantitatively the concept of the electric field;
- state Gauss' law and apply it to solve physics problems;
- describe qualitatively and quantitatively the concept of the electric potential;
- state Kirchhoff's rules for DC circuits and apply them to solve physics problems;
- state Faraday's law of electromagnetic induction and apply it to solve physics problems; and
- describe qualitatively and quantitatively the concept of electromagnetic waves.



## Department of Mathematics and Physics

### PHYS 3310 Modern Physics

**Adoption date: August 23, 2021.**

#### **COURSE DESCRIPTION**

An introduction to the foundations of modern physics. Topics include special and general relativity, kinetic theory of matter, electromagnetic quantization, light and energy, wave-matter duality of light, the Schrodinger Equation, nuclear physics and elementary particle theory. Prerequisites: PHYS 2326/PHYS 2126 and corequisites: MATH 2415.

#### **STUDENT LEARNING OUTCOMES**

Upon successful completion of the course, the student will be able to:

- Apply the basic principles of special relativity to solve problems
- Understand and explain the basis for quantum mechanics and be able to solve Schrodinger's equation for simple potentials
- Be able to apply statistical physics to describe how semiconductors work
- Calculate the energy required/released in nuclear reactions
- Know the fundamental particles in the Standard Model
- Be able to apply Hubble's Law, and use the Friedmann equation to describe the evolution of the Universe.

## Department of Mathematics and Physics

### PHYS 3320

#### Electromagnetic Field Theory

**Adoption date: Fall 2018**

#### **COURSE DESCRIPTION**

A mathematical treatment of the fundamentals of classical electromagnetic theory. Topics include electrodynamics, vector calculus, theory of dielectrics, magnetostatic fields, electromagnetic induction, magnetic fields of currents, and Maxwell's equations.

Prerequisites: PHYS 2326/2126 and MATH 3330.

#### **STUDENT LEARNING OUTCOMES**

Upon successful completion of the course, the student will be able to:

- Apply vector analysis in the description and study of electromagnetic fields.
- Apply the gradient, divergence, and curl operators to solve electromagnetic field problems.
- Derive Gauss's theorem (Green's theorem, divergence theorem) and apply it to solve electromagnetic field problems.
- Derive Stokes's theorem and apply it to solve electromagnetic field problems.
- Derive Maxwell's equations in integral and differential form.
- Derive the wave equation for electromagnetic waves from Maxwell's equations.

# Department of Mathematics and Physics

## PHYS 4315

### Mathematical Methods of Physics

**Adoption date: August 23, 2021.**

#### **COURSE DESCRIPTION**

A course presenting mathematical techniques used in physics and engineering. The course will survey, at a brief introductory level and from a physics perspective, numerous mathematical techniques from areas such as infinite series, integral transformation, applications of complex variables, matrices and tensors, special functions, partial differential equations, Green's functions, perturbation theory, integral equations, calculus of variations, and groups and group representations. Prerequisites: PHYS 2326/2126 and MATH 3330.

#### **STUDENT LEARNING OUTCOMES**

Upon successful completion of the course, the student will be able to:

- use complex numbers in applications;
- apply vector algebra methods for solving problems in physics and engineering;
- solve ordinary differential equations;
- use Fourier series in physics and engineering applications;
- understand the fundamental concepts of mathematical physics;
- effectively use mathematical methods in applications;
- understand and use proper terminology of mathematical physics