COLLIN COLLEGE EXPANDED GENERIC COURSE SYLLABUS

COURSE INFORMATION

Course Number: MATH 2305
Course Title: Discrete Mathematics
Credit Hours: 3
Lecture Hours: 3
Lab Hours: 0

Prerequisite
MATH 2413 with a C or better.

Course Description
A course designed to prepare math, computer science, and engineering majors for a background in abstraction, notation, and critical thinking for the mathematics most directly related to computer science. Topics include: logic, relations, functions, basic set theory, countability and counting arguments, proof techniques, mathematical induction, combinatorics, discrete probability, recursion, sequence and recurrence, elementary number theory, graph theory, and mathematical proof techniques.

Textbook/Supplies
Onsite Courses: *Discrete Mathematics and Its Applications* 8th ed. Kenneth H. Rosen, 2019 McGraw-Hill

Supplies: Graphing calculator required.

STUDENT LEARNING OUTCOMES (SLO)

Upon completion of this course the students should be able to do the following:

1. Construct mathematical arguments using logical connectives and quantifiers. (Communication)
2. Verify the correctness of an argument using propositional and predicate logic and truth tables. (Critical Thinking)
3. Demonstrate the ability to solve problems using counting techniques and combinatorics in the context of discrete probability. (Empirical and Quantitative)
4. Solve problems involving recurrence relations and generating functions. (Empirical and Quantitative)
5. Use graphs and trees as tools to visualize and simplify situations.
6. Perform operations on discrete structures such as sets, functions, relations, and sequences.

7. Construct proofs using direct proof, proof by contraposition, proof by contradiction, proof by cases, and mathematical induction. (Communication)
8. Apply algorithms and use definitions to solve problems to prove statements in elementary number theory. (Critical Thinking)

METHOD OF EVALUATION

Course requirements
Attending class**,** completing homework assignments, and completing required exams.

Course format
Lecture and guided practice.

A minimum of three proctored exams and a proctored comprehensive final exam are required. Homework and/or quizzes may be used in addition to exams. The final exam must count at least as much as any regular exam. The specific weight of each evaluation component will be detailed in the individual instructor's syllabus. Credit for all out-of-class coursework—including homework assignments, service-learning projects, and other assessments and learning activities—may not exceed 25% of the total course grade. At least 75% of a student's grade must consist of proctored exams. No student may retake any of these exams.

COURSE POLICIES

College-wide policies are pre-loaded into the Concourse Syllabi and are not duplicated in the Expanded Generic Syllabi for each course.

Instructor specific policies should be added to the Concourse Syllabus.

COURSE CONTENT

Proofs and derivations will be assigned at the discretion of the instructor. The student will be responsible for knowing all definitions and statements of theorems for each section outlined in the following modules.

Module 1: The Foundations: Logic and Proofs

The student will be able to:

1. Determine if a sentence is a proposition. SLO 1
2. Use the logical operators “and”, “or”, and “not” to create compound propositions. SLO 1
3. Create compound propositions that are conditional or bi-conditional statements. SLO 1
4. State converse, contrapositive, and inverse of a conditional statement. SLO 1
5. Create truth tables for compound propositions. SLO 1
6. Translate sentences into logical propositions. SLO 1
7. Translate logical propositions into sentences. SLO 1
8. Determine if two propositions are logically equivalent. SLO 1
9. Construct new propositions that are logically equivalent to a given proposition. SLO 1
10. Create a propositional function and determine its truth value. SLO 2
11. Quantify a propositional function. SLO 2
12. Construct new quantified propositions that are logically equivalent to a given quantified proposition. SLO 2
13. Use nested quantifiers in propositional statements. SLO 2
14. Use Rules of Inference to show that an argument is valid. SLO 2
15. Prove a statement using direct proof, proof by contraposition, or proof by contradiction. SLO 7

Module 2: Basic Structures: Sets, Functions, Sequences, and Sums

The student will be able to:

1. Show that two sets are equal and determine the size of a set. SLO 6
2. For a given set, find the power set. SLO 6
3. Find the Cartesian product of two (or more) sets. SLO 6
4. Find the complement of a set. Find the union or intersection of two (or more) sets. SLO 6
5. Verify set identities. SLO 6
6. Determine if a mapping is a function. SLO 6
7. Given a function, identify the domain, codomain, and range. SLO 6
8. Determine if a function is a one-to-one function. SLO 6
9. Determine if a function is an onto function. SLO 6
10. Determine if a function is a one-to-one correspondence. SLO 6
11. Find the inverse function of a given function. SLO 6
12. Find the sum, product or composition to two functions. SLO 6
13. Find the terms of a sequence given by an explicit formula or given by a recurrence relation. SLO 6
14. Given several terms of a sequence, find a formula for the n-th term of the sequence. SLO 6
15. Find the sum of terms of a sequence given using summation notation. SLO 6

Module 3: The Fundamentals: Algorithms and Integer

The student will be able to:

1. Evaluate an algorithm for given inputs. SLO 8
2. Express the growth of a function using Big-O notation. SLO 8
3. Express the growth of a function using Big-Omega notation. SLO 8
4. Express the growth of a function using Big-Theta notation. SLO 8
5. Determine the growth of a combination of functions involving sums or productions. SLO 8
6. Determine the complexity of an algorithm. SLO 8
7. Determine if one number divides another number. SLO 8
8. Express the quotient in terms of the divisor and remainder using the division algorithm. SLO 8
9. Determine if two numbers are congruent for a given modulus. SLO 8
10. Use properties of congruence to simplify expressions. SLO 8
11. Given an integer, find the expansion of the integer for a given base b. SLO 8
12. Determine if an integer is prime or composite. SLO 8
13. Use the Fundamental Theorem of Arithmetic to express the prime factorization of an integer. SLO 8
14. Find the least common multiple and greatest common divisor of two (or more) integers. SLO 8
15. Express the greatest common divisor of two integers as a linear combination of the original two integers. SLO 8
16. Find the inverse of an integer modulo m. Use this inverse to solve a linear congruence. SLO 8
17. Use Fermat's Little Theorem to compute remainders modulo m. SLO 8
18. Use RSA cryptosystem to encrypt or decrypt a message. SLO 8

Module 4: Inductions and Recursion

The student will be able to:

1. Use Mathematical Induction to prove a statement is true for all positive integers. SLO 7
2. Define a function recursively. SLO 4
3. Prove a recursive algorithm is correct. SLO 4

Module 5: Counting

The student will be able to:

1. Apply the proper counting principle(s) (The Product Rule, the Sum Rule, the Subtraction Rule, or the Division Rule) to counting problems. SLO 3
2. Use the Pigeonhole Principle to solve counting problems. SLO 3
3. Calculate the number of permutations or combinations. SLO 3
4. Use permutations and combinations to solve counting problems. SLO 3
5. Solve permutation and combination problem when repetition is allowed. SLO 3

Module 6: Discrete Probability

The student will be able to:

1. Calculate the probability of an event on a finite sample space. SLO 3
2. Calculate the probability of the complement of an event. SLO 3
3. Calculate the probability of the union of two events. SLO 3

Module 7: Relations

The student will be able to:

1. Determine if a relation is a function. SLO 6
2. Determine if a relation is reflexive, symmetric, or transitive. SLO 6
3. Create a generating function and use the generating function to solve a counting problem. SLO 4

Module 8: Graphs and Trees

The student will be able to:

1. Classify a graph as a simple graph or multigraph. SLO 5
2. Determine if a graph is a directed graph. SLO 5
3. Determine the degree of a vertex of a graph. SLO 5
4. Determine if a graph is a bipartite graph. SLO 5
5. Determine if a graph is a tree. SLO 5
6. Determine if a tree is an m-ary tree. SLO 5
7. Given a vertex of a graph, determine if it is a root, if it is internal, if it is a parent or a child of another vertex, its ancestors, its siblings, or its descendents. SLO 5