C O U R S E   O U T L I N E
MT. HOOD COMMUNITY COLLEGE DISTRICT
Gresham, Oregon   97030

* New ____________

*Revised ____________

* Review only (no changes) 10/1/07
(Date)

* COURSE TYPE Please check appropriate box:

- ☒ Lower Division Collegiate
- ☐ Occupational Supplementary
- ☐ Occupational Preparatory
- ☐ Other Education, Including General Ed & Adult Ed

COURSE TITLE Discrete Mathematics

COURSE NUMBER MTH231

COURSE CREDIT 4

* Lecture Hours 4 | 40 Wkly/Term

Lab Hours ___ | ___ Wkly/Term

Seminar Hours ___ | ___ Wkly/Term

* GRADING STATUS:

- ☒ Letter Grade Only
- ☐ S/U Only
- ☐ Optional
- ☐ No Grade

* HEADCOUNT LOADING:

- ☐ Yes
- ☒ No

* Factor ____________

Guided Studies Requirement:
Student must be proficient in:

- ☒ Reading (RD90)
- ☒ Writing (WR90)
- ☒ Mathematics (MTH20)
- ☐ Not applicable

For Instruction Office Use Only
General Education Category
Apply general requirement or distribution to:

AA______________ AS_____________ AS/OT-Bus___________

AAS______________AGS___________

VP Approval _________________________Date_____________

1) Prepared by	Date	4) Approved by Dean	Date
2) Approved by Distance Education Admin.	Date	5) Curriculum Committee	Date
3) Approved by Department Chair	Date	6) Approved by VP for Student Learning	Date

* See legend/definition for explanation

COURSE DESCRIPTION: (for catalog)
This course includes finite and infinite sets, mathematical induction, switching circuits, relations and functions, theory of graphs with applications related to computer science. It provides introduction to Boolean algebra and recursion. Computer laboratory component may be included.

PREREQUISITE:
MTH111 with a C or better, or suitable performance on the mathematics placement exam.

INSTRUCTIONAL MATERIALS REQUIRED OF STUDENT: (text, supplies, etc.)
Text as directed by instructor.

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

PERFORMANCE OBJECTIVES

1. Logic

   a. Define a proposition and indicate whether a given sentence is a proposition.
   b. Given a logical statement form composed of negations, conjunctions, disjunctions, "exclusive or", conditionals and equivalences, construct a truth table.
   c. Translate between certain English sentences and logical statements.
   d. Given a truth table for an unspecified proposition, find a logical statement that satisfies it.
   e. Determine if a given statement form is a tautology, contradiction or neither, from the table.
   f. Determine whether two logical statement forms are equivalent using logical equivalences (DeMorgan's Law, etc.).
   g. State the principle of duality.
   h. Given a logical equivalence and proof, state and prove the dual.
   i. Given a conditional statement in English, state the converse, inverse, and contrapositive. Indicate which are equivalent and prove (truth tables).
   j. Demonstrate "proof by contradiction" by proving certain statements.
   k. Given an argument in the form of a set of premises and a conclusion, determine its validity using a truth table.

2. Sets

   a.. Review the following concepts: sets, membership, implicit & explicit notation, subsets, proper subsets, proper subsets, union, intersection, equality, infinite and finite sets, empty set.
   b. Use Venn Diagrams to illustrate relationships between sets.
   c. Define and answer questions involving the following: complement, set difference, cardinality, power set.
   d. Count the elements in the union of 2 or 3 sets using the principle of inclusion-exclusion.
   e. Prove or disprove various statements among binary operations on sets and set containment by converting to corresponding logic statements and using truth tables.
   f. Prove or disprove various statements about sets using properties such as DeMorgan's laws, distributive laws, absorption, idempotence, etc., or by finding a counter example.
   g. Perform applications of set concepts including languages on an alphabet (computer science).

3. Boolean Algebra

   a. Given certain sets with 2 binary operations, determine whether or not they are Boolean algebras, and justify the conclusion.
   b. Translate among the languages of set theory, logic and Boolean algebra.
   c. Demonstrate that a Boolean algebra is a poset.
   d. Prove various properties of a Boolean algebra from the given axioms and previous theorems.

4. Switching Circuits

   Upon completion of the course, the student should be able to:

   a. Draw diagrams to represent the following gates: AND, OR, NAND, NOR, INVERTER.
   b. Draw a circuit diagram to represent a given Boolean expression.

c. Given a verbal description of a function to be performed, design a circuit to achieve the objective (e.g. half-adder, full-adder, three-way light switch, comparing two binary numbers, etc.)
d. Determine whether a given Boolean expression is in SOP form (sum of products). If not, simplify to SOP form.
e. Given a Boolean expression, form a Karnaugh map and find a minimal sum.
f. Given a Boolean expression, use the Quine-McClusky method to find a minimal sum.
g. Given certain circuit diagram, find a simpler equivalent circuit when possible.

5. Relations

a. Define and find the Cartesian product of two or more sets.
b. Define a binary relation, R, from A to B. Use (a,b) € R notation as well as aRb notation. Define an n-ary relation.
c. Define the reflexive, symmetric, antisymmetric, and transitive properties, determine when a given relation possesses each.
d. Define two special classes: equivalence relations and partial orders.
e. Given a relation from a relation table or a worded example, determine whether it is an equivalence relation or a partial order or neither.
f. Given two relations, R^1 and R^2 fine $R^1 \cap R^2$, $R^1 \cup R^2$, R^1, Θ R^2, $R^1 - R^2$, $R^1 \circ R^2$.
g. Find the symmetric, reflexive, and transitive closures of a given relation.

6. Relations

a. Review basic concepts of function including domain, codain, image, one-to-one, constant function, composite, inverse, function as a relation.
b. Define and answer questions involving the following concepts; preimage, surjective, bijective, equality of functions, one-sided inverse, restriction to a subset, induced function on a power set.
c. Represent functions using infix, prefix, or postfix notation, and translate expressions among these notations.
d. Define f is O (g)… (big O notation). Given two functions f and g, determine if f is O (g).
e. Given a recurrence equation and initial conditions, determine the first few terms, determine its order, and determine if it is linear.
f. Solve certain linear recurrence equations of first and second order.
g. Discuss possible solutions of non-linear recurrence equations vis a vis deterministic chaos.
h. State the First Principle of Mathematical Induction and use it to prove certain statements about the set of natural numbers.
i. State the Second Principle of Mathematical Induction and use it to prove certain statements about the set of natural numbers.
j. Define an inductively defined set and use mathematical induction to prove certain statements about inductively defined sets other than N. (Good examples included languages on an alphabet or sets of digraphs, etc.)

7. Graph Theory

a. State the definition for a directed graph and an undirected graph.
b. State definitions of certain terms used in graph theory (varies by text) such as vertex, edge, parallel edges, multiple edges, simple graph, multigraph, loop, connected, adjacent, incident, isolated point, degree, complete, bipartite, cycle subgraph, regular, adjacency matrix, incidence matrix, isomorphic, path, walk, closed, bridge, cut point, component, trail, order, in-degree, planar, tree, spanning, root, ancestor, leaf, height, internal, binary tree, strictly binary tree, networks, Hamiltonian path, Eulerian circuit.
c. Answer questions involving the above concepts and prove certain statements (including induction proofs).
d. Perform applications of graph theory. The following list represents some of the possible choices:

Traveling Salesman problem (finding least expensive circuit)
Scheduling and critical paths
Coloring problems and scheduling
Sorting data
Searching for data
Data structure
Decision trees
Gray codes and Hamilton circuits
Chemical compounds and multigraphs
Reachability and communications networks

GENERAL INSTRUCTIONAL METHODS:

The concept should be motivated through applications principally from computer sciences but additionally from other areas as well.

The approach should be mathematically precise but not overly rigorous. Definitions and theorems should be presented clearly to model the precision of language that mathematics requires. Some proofs should be presented carefully in class accompanied by a discussion of the strategy and informal insight. Mathematical Induction is an especially important proof technique in discrete math and computer science. It should be illustrated with many types of examples.

Two important goals for this course are to develop mathematical reasoning and to achieve a perspective of discrete math as a language for describing certain structures. The reasoning might be developed by a process that includes the following components: 1)careful modeling of problem solving in lecture as well as in the text, 2) assignments that make it clear to the student that original reasoning and problem solving are required – more than just cloning examples, 3) feedback on written work and class discussions.

The perspective of mathematics as a language should be discrete in class. This can motivate the acquisition of vocabulary and proper usage in order to achieve the goal of precise communication.

Some software packages for discrete mathematics are available. Their use may help motivate students, especially the computer science majors. Some of the video series For All Practical Purposes relate to discrete math and may be effectively used in class or as optional assignments or projects. It is recommended that in addition to regular homework type exercises, some longer term problems be given. These might involve synthesizing several concepts, and could be done individually or in groups. Students might be allowed some choice on projects based on individual interest and these could include programming projects.

The material on graph theory varies considerable among discrete math textbooks. To avoid confusion, it is recommended that the instructor follow the terminology and development of the current text. Be especially careful in bringing in supplementary material since even the basic definitions and theorems from another book may produce inconsistency. It is important to make the students aware of this as well.

EVALUATION PROCESS:

Completion of course objectives and assigned papers and projects according to criteria provided by the instructor will be required. Grading will be in accordance with college standards.