



# **DIVISION *of* MATHEMATICS & COMPUTER SCIENCE**

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Computer Information Systems  
Computer Science, A.A.  
Engineering

Mathematics  
Mathematics/Computer Science  
Mathematics Education

**MATHEMATICS & COMPUTER SCIENCE**

# **MATHEMATICS & COMPUTER SCIENCE**

## **Computational Physics**

(Details & requirements for this major are in the Division of Natural Sciences, page 136.)

## **Computer Information Systems Major**

			<b>HOURS</b>
<b>General Studies</b>			
ENGL	101	Written Communication II	3
ENGL	102	Written Communication	2
COMM	171	Speech Communication	3
PSYC	180	College Orientation	1
PSYC	182	General Psychology	3
SOC	151	Principles of Sociology	3
MATH	111	Basic Probability & Statistics	3
MATH	124	Applied Calculus or Math 131	3
		Literature Elective	3
		History Elective	3
		Art/Drama/Music Elective	3
BIBL	215	Old Testament Literature	3
BIBL	216	New Testament Literature	3
THEO	110	Exploring the Christian Faith	3
PHYS	211	Electronics	4
		Research Methods, or Second Science with Lab	4
PHIL	150	Logic & Critical Thinking	2
PHIL	250	Introduction to Philosophy	3
PHIL	452	Senior Experience	1
PHED	100	Lifelong Physical Awareness	0.5
PHED	112-136	Physical Education Activities	<u>1.5</u>
			<b>55</b>
<b>Computer Core</b>			
CPSC	121	Computer Programming I	3
CPSC	122	Computer Programming II	3
CPSC	221	Computer Programming III	3
CPSC	222	Computer Programming IV	3
CPSC	321	Systems Analysis	3
CPSC	322	Computer Systems	3
CPSC	323	Database	3
CPSC	331	Network Design & Implementation	3
CPSC	355	Information Systems I	3
CPSC	455	Information Systems II	3
CPSC	421	Senior Project/ Internship	3
MATH	321	Numerical Analysis, or	3
CPSC	411	Special Topics, or	(3)
CPSC	429	Independent Study	<u>(3)</u>
			<b>36</b>
<b>Business Core</b>			
ACCT	203	Fundamentals of Accounting I	3
ACCT	204	Fundamentals of Accounting II	3
ECON	233	Principles of Economics	3
ECON	329	Intermediate Macroeconomics, or	3
ECON	330	Intermediate Microeconomics	(3)
BADM	286	Finite Math for Business	3
BADM	331	Operations Management	3
BADM	321	Principles of Management	<u>3</u>
			<b>21</b>
Electives needed to complete the degree			12

## Computer Information Systems Minor

			HOURS
CPSC	121-122	Computer Programming I & II	6
CPSC	321	Systems Analysis	3
CPSC	355	Information Systems I	3
CPSC	455	Information Systems II	3
CPSC		Elective in Computer Science	<u>3</u>
			<b>18</b>

## Computer Science Major A.A. Degree

### General Studies

THEO	110	Exploring the Christian Faith	3
COMM	171	Speech Communication	3
ENGL	101	Written Communication II	3
PSYC	180	College Orientation	1
PSYC	182	General Psychology	3
PHED	100	Lifelong Physical Awareness	0.5
SOC	151	Principles of Sociology	3
BIBL	216	New Testament Literature, or	3
BIBL	215	Old Testament Literature	(3)
MATH	111	Music/Art/Literature/Drama	3
PHED	112-136	Physical Education Activity	0.5
PHIL	150	Logic & Critical Thinking	<u>2</u>
			<b>25</b>

### Major

CPSC	121-122	Computer Programming I & II	6
CPSC	224-225	Computer Programming III & IV	6
CPSC	321	Systems Analysis	3
CPSC		Elective in Computer Science	6

### Required Cognate

OADM	161	Basic Keyboarding, or Proficiency	2 (0)
Electives needed to complete the degree			14

## Engineering Major Combination Program—B.S. in Math/Physics

This program is offered through an agreement between Bethel College and the University of Notre Dame. The student completes three years of study at the college and two additional years in engineering at the university. At the end of one year of satisfactory study at the university, Bethel College awards a B.S. degree in mathematics/physics, and at the end of the second year, Notre Dame awards a B.S. degree in engineering. As part of Bethel College's requirements, each engineering student must maintain a 3.0 cumulative grade point average; earn a grade of at least "C" in all courses; and receive a favorable recommendation by the faculty of the Division of Mathematics and Computer Science and the Division of Natural Science. As with any cooperative agreement, the student must officially apply for admission to the University of Notre Dame as part of the transfer process. Students interested in majoring in engineering should contact the Office of Admissions and the divisional chairperson for further information regarding performance standards and available programs.

### General Studies

BIBL	215	Old Testament Literature	3
COMM	171	Speech Communication	3
ENGL	101	Written Communication II	3
ENGL	102	Written Communication III	3
PSYC	180	College Orientation	1
PSYC	182	General Psychology, or	3

# **MATHEMATICS & COMPUTER SCIENCE**

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			<b>HOURS</b>
SOC	151	Principles of Sociology	(3)
BIBL	216	New Testament Literature	3
		Economics/History Elective	3
FA	170	Perspectives in Fine Arts, or	3
LIT		Literature Elective	(3)
THEO	110	Exploring the Christian Faith	3
PHIL	250	Introduction to Philosophy	3
PHIL	452	Senior Experience	2
PHED	100	Lifelong Physical Awareness	0.5
PHED	112-136	Physical Education Activities	<u>1.5</u>
			<b>35</b>

## **Major**

CHEM	163	General Chemistry I	4
CHEM	164	General Chemistry II	4
CPSC	121	Computer Programming I	3
MATH	131	Calculus I	3
MATH	132	Calculus II	4
MATH	231	Calculus III	3
MATH	232	Differential Equations	3
MATH	241	Linear Algebra	3
MATH	252	Mathematical Statistics	3
PHYS	121	General Physics I	4
PHYS	122	General Physics II	4
PHYS	211	Electronics	4
PHYS	301	Quantum Physics	<u>4</u>
			<b>46</b>

Plus **one** of the following two-course sequences:

PHYS	225	Statics	3
PHYS	226	Dynamics	3
CHEM	261	Organic Chemistry I	4
CHEM	262	Organic Chemistry II	4
CPSC	122	Computer Programming II	3
MATH	210	Discrete Mathematics	<u>3</u>
			6-8

Plus **two** of the following courses:

MATH	321	Numerical Analysis	3
MATH	341	Abstract Algebra I	3
MATH	342	Abstract Algebra II	(3)
MATH	361	Real Analysis I	(3)
MATH	362	Real Analysis II	(3)
PHYS	332	Waves & Optics	(4)
PHYS	344	Electricity & Magnetism	<u>(4)</u>
			6-8

## **Mathematics Major**

### **General Studies**

BIBL	215	Old Testament Literature	3
COMM	171	Speech Communication	3
ENGL	101	Written Communication II	3
ENGL	102	Written Communication III	3
PSYC	180	College Orientation	1
PSYC	182	General Psychology	3
PHED	100	Lifelong Physical Awareness	0.5
SOC	151	Principles of Sociology	3
BIBL	216	New Testament Literature	3
		Foreign Language (two semesters)	6

# **MATHEMATICS & COMPUTER SCIENCE**

			<b>HOURS</b>
		History Elective	3
		Art/Drama/Music	3
		Literature	3
PHIL	150	Logic & Critical Thinking	2
PHIL	250	Introduction to Philosophy	3
THEO	110	Exploring the Christian Faith	3
PHIL	452	Senior Experience	1
PHED	112-136	Physical Education Activities	<u>1.5</u>
			<b>48</b>
<b>Major</b>			
MATH	131	Calculus I	3
MATH	132	Calculus II	4
MATH	231	Calculus III	3
MATH	232	Differential Equations	3
MATH	241	Linear Algebra	3
MATH	252	Mathematical Statistics	3
MATH	331	Modern Geometry	3
MATH	341	Abstract Algebra I	3
MATH	342	Abstract Algebra II	3
MATH	361	Real Analysis I	3
MATH	362	Real Analysis II	3
MATH	412	Topology	3
CPSC	121	Computer Programming I	3
CPSC	122	Computer Programming II	<u>3</u>
			<b>43</b>
<b>Required Cognates:</b>			
PHYS	121	General Physics I	4
PHYS	122	General Physics II	<u>4</u>
			<b>8</b>
Electives needed to complete the degree			25

## **Mathematics Minor**

MATH	131	Calculus I	3
MATH	132	Calculus II	4
MATH	231	Calculus III	3
MATH	241	Linear Algebra	3
MATH	232	Differential Equations, or	3
MATH	252	Mathematical Statistics	(3)
MATH	331	Modern Geometry	3
MATH	341	Abstract Algebra I	3
MATH	361	Real Analysis I	<u>3</u>
			<b>25</b>

## **Mathematics/Computer Science Major**

### **General Studies**

ENGL	101	Written Communication II	3
ENGL	102	Written Communication III	3
COMM	171	Speech Communication	3
PSYC	180	College Orientation	1
PSYC	182	General Psychology	3
SOC	151	Principles of Sociology	3
		Literature	3
		History	3
		Art/Drama/Music	3
PHYS	121	General Physics I, or	4
NS	110	Environmental Science, or	(4)
BIOL	333	Biodiversity, or	(3)
CHEM	163	General Chemistry I	(4)
THEO	110	Exploring the Christian Faith	3
BIBL	215	Old Testament Literature	3

# **MATHEMATICS & COMPUTER SCIENCE**

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			<b>HOURS</b>
BIBL	216	New Testament Literature	3
PHIL	150	Logic & Critical Thinking	2
PHIL	250	Introduction to Philosophy	3
PHIL	452	Senior Experience	1
PHED	100	Lifelong Physical Awareness	0.5
PHED	112-136	Physical Education Activities	<u>1.5</u>
			<b>46</b>
<b>Computer Core</b>			
CPSC	121	Computer Programming I	3
CPSC	122	Computer Programming II	3
CPSC	224	Computer Programming III	3
CPSC	225	Computer Programming IV	3
CPSC	321	Systems Analysis	3
CPSC	322	Computer Systems	3
CPSC	421	Senior Project/Internship	<u>3</u>
			<b>21</b>
<b>Plus six hours from the following:</b>			<b>6</b>
CPSC	323	Database	(3)
CPSC	331	Networks	(3)
CPSC	411	Special Topics	(3)
CPSC	429	Independent Study	(1-4)
BADM	331	Operations Management	(3)
<b>Mathematics Core</b>			
MATH	131	Calculus I	3
MATH	132	Calculus II	4
MATH	231	Calculus III	3
MATH	232	Differential Equations	3
MATH	241	Linear Algebra	3
MATH	252	Mathematical Statistics	3
MATH	321	Numerical Analysis	3
MATH	341/342	Abstract Algebra, or	6
MATH	361/362	Real Analysis	<u>(6)</u>
			<b>28</b>
<b>Required Cognate:</b>			
PHYS	211	Electronics	4
Electives needed to complete the degree			19

## **Mathematics Education Major**

<b>General Studies</b>			
BIBL	215	Old Testament Literature	3
COMM	171	Speech Communication	3
ENGL	101	Written Communication II	3
ENGL	102	Written Communication III	3
PSYC	180	College Orientation	1
PSYC	182	General Psychology	3
PHED	100	Lifelong Physical Awareness	0.5
SOC	151	Principles of Sociology	3
THEO	110	Exploring the Christian Faith	3
BIBL	216	New Testament Literature	3
		Foreign Language (two semesters)	6
HIST		History Elective	3
LIT		Literature	3
FA	170	Perspectives in Fine Arts	3
PHIL	150	Logic & Critical Thinking	2
PHIL	250	Introduction to Philosophy	3
PHIL	452	Senior Experience	1

# **MATHEMATICS & COMPUTER SCIENCE**

			<b>HOURS</b>
PHED	112-136	Physical Education Activities	<u>1.5</u>
			<b>48</b>
<b>Major</b>			
MATH	131	Calculus I	3
MATH	132	Calculus II	4
MATH	231	Calculus III	3
MATH	232	Differential Equations	3
MATH	241	Linear Algebra	3
MATH	252	Mathematical Statistics	3
MATH	331	Modern Geometry	3
MATH	341	Abstract Algebra I	3
MATH	342	Abstract Algebra II	3
MATH	361	Real Analysis I	3
MATH	362	Real Analysis II	3
CPSC	121	Computer Programming I	3
PHYS	121	General Physics I	<u>4</u>
			<b>41</b>
<b>Professional Education</b>			
EDUC	102	Foundations of Education	3
EDUC	204	Diversity in the Classroom	3
EDUC	205	Educational Pedagogy I	3
EDUC	305	Educational Pedagogy II	3
PSYC	285	Adolescent Growth & Development	2
SCED	446	Specific Methods in Math	2
SCED	448	Developmental Reading	3
SCED	449	Student Teaching	8
EDUC	441	Student Teaching Seminar	<u>0-2</u>
			<b>27-29</b>

*See TEACHER EDUCATION (page 56) for program admission and other information.*

## **Mathematics Education Minor**

MATH	131	Calculus I	3
MATH	132	Calculus II	4
MATH	231	Calculus III	3
MATH	241	Linear Algebra	3
MATH	232	Differential Equations, or	3
MATH	252	Mathematical Statistics	(3)
MATH	331	Modern Geometry	3
MATH	341	Abstract Algebra I	3
SCED	446	Specific Methods in Mathematics	<u>2</u>
			<b>24</b>

## Computer Science (CPSC)

- 120. Introduction to Computers & Data Processing** **3 Hours**  
An introduction to computers and data processing history, computer architecture, impact of the computer on society and Visual Basic programming. Emphasis is on the terminology associated with computing and a computer language.
- 121. Computer Programming I** **3 Hours**  
An introduction to Computer Science and programming using a high level, object oriented, GUI based language. Emphasis is on the use of problem solving methods, algorithm development, code design, documentation, debugging, and elementary data and control structures.  
**Prerequisite:** MATH 102 or permission of instructor.
- 122. Computer Programming II** **3 Hours**  
Continuation of CPSC 121, with emphasis on data structures, pointers, objects, arithmetic and logical expressions, iterations, arrays, sorting and searching techniques and group programming.  
**Prerequisite:** CPSC 121.
- 224. Computer Programming II** **3 Hours**  
Continuation of CPSC 122 with emphasis on economy and efficiency of code and data structure design.  
**Prerequisite:** CPSC 122.
- 225. Computer Programming IV** **3 Hours**  
Continuation of CPSC 224.  
**Prerequisite:** CPSC 224.
- 321. Systems Analysis** **3 Hours**  
Structured systems analysis and the development cycle, data flow diagrams, data dictionaries, decision trees and tables, query handling, structured design, with an emphasis on case studies.  
**Prerequisite:** CPSC 122.
- 322. Computer Systems** **3 Hours**  
Survey of hardware and systems software, with a brief introduction to logic circuits and Boolean algebra, basic computer structure, addressing methods, machine program sequencing, process and memory management.  
**Prerequisites:** CPSC 224, PHYS 211.
- 323. Database** **3 Hours**  
An introduction to the design, implementation and management of database systems. Database structures: a review of file properties, data structures, representation relationships through trees, networks and record pointers. Database modeling: logical and physical design, schemas and subschemas, analysis of hierarchical, network and relational database systems.  
**Prerequisite:** CPSC 121 or permission of instructor.
- 331. Networks** **3 Hours**  
The study of computer network operating systems theory, administration and implementation. Emphasis is on developing and implementing a LAN.
- 355. Information Systems I** **3 Hours**  
An introduction to the management, use and development of information technology systems in business. The role of computer hardware, software, personnel and administration in computer-based information systems in central.
- 411. Special Topics** **3 Hours**  
An opportunity to study trends and areas of research in computer science that may not be covered in other courses. Emphasis is on career preparation. (Offered on demand.)  
**Prerequisite:** CPSC 225.
- 422. Senior Project/Internship** **3 Hours**  
Research on a selected topic culminating in a written thesis and oral presentation, OR faculty supervised practical experience in an actual computing environment. (Offered on demand.)  
**Prerequisite:** Permission of instructor and application from prior semester.
- 429. Independent Study in Computer Science** **1-4 Hours**  
An opportunity for directed study, research, or completion of a special project in computer science. (Offered on demand.)  
**Prerequisite:** Permission of instructor.
- 455. Information Systems II** **3 Hours**  
A continuation of Information Systems I with an emphasis on communication skills, ethics, critical thinking and team-working.

## Mathematics (MATH)

- 090. Basic Mathematics** **3 Hours**  
A review of the basic functions of arithmetic, numeration systems, fractions, problem solving, elementary statistics and introduction to algebra. Required for those whose math scores are below 450 (SAT) or 17 (ACT).

- 101. College Algebra I** **3 Hours**  
Review of real numbers; arithmetic of whole numbers, fractions, decimals and signed numbers; simple algebraic expressions; linear equations and inequalities in one variable; integral exponents; radicals; fractional exponents; multiplication of algebraic expressions; factoring; fractional expressions; and quadratics.  
**Prerequisite:** SAT math score of 450 or equivalent.
- 102. College Algebra II** **3 Hours**  
Algebraic expressions; equations and inequalities; relations and their graphs; introduction to the study of functions including exponential, logarithmic, polynomial and rational functions; and systems of equations.  
**Prerequisite:** MATH 101 or equivalent.
- 111. Basic Probability & Statistics** **3 Hours**  
A general studies course in statistics covering such subjects as averages, variability, standard scores, normal curves, correlation, linear regression, probability, sampling, hypothesis testing and chi-square.  
**Prerequisite:** MATH 090 or proficiency.
- 122. Precalculus & Trigonometry** **3 Hours**  
Trigonometric functions and identities; laws of sine and cosine; analytical geometry; in-depth study of functions; and introduction to the concept of a limit.  
**Prerequisite:** MATH 102 or equivalent.
- 124. Applied Calculus** **3 Hours**  
One semester of differential and integral calculus with emphasis on graphical, numerical and descriptive techniques. Topics from multivariable calculus and differential equations. Applications to economics, life sciences, physical sciences and other areas of student interest are emphasized throughout via student projects and presentations.  
**Prerequisite:** MATH 102 or equivalent.
- 131. Calculus I** **3 Hours**  
Functions; limits; continuity; concept of the derivative; differentiation of algebraic, rational, exponential, logarithmic and trigonometric functions; Rolle's Theorem; the Mean Value Theorem; applications of the derivative, including maxima and minima, graphing and optimization. Three hours of lecture and two hours of lab each week.  
**Prerequisite:** MATH 122 or equivalent.
- 132. Calculus II** **4 Hours**  
Anti-differentiation; Riemann integration; Fundamental Theorem of Calculus; techniques of integration; applications of integrals, including finding areas and volumes; improper integrals; indeterminate forms and L'Hopital's Rule; infinite sequences; infinite series; and parametric forms.  
**Prerequisite:** MATH 131.
- 210. Discrete Mathematics** **3 Hours**  
An introduction to mathematical techniques appropriate for computer engineering majors. Topics include mathematical logic, induction, set theory, relations, functions, recursion, recurrence relations, introduction to asymptotic analysis, introduction to algebraic structures, graphs and machine computation.  
**Prerequisite:** MATH 131, CPSC 121.
- 231. Calculus III** **3 Hours**  
Fundamentals of vectors; vector-valued functions; limits, derivatives and integrals of vector-valued functions; fundamentals of multivariable functions; partial differentiation; chain rule for multivariable functions; extrema of multivariable functions; multiple integrals; cylindrical coordinates, spherical coordinates, vector fields; line integrals; surface integrals; Green's Theorem; Stoke's Theorem; and the Divergence Theorem.  
**Prerequisite:** MATH 132.
- 232. Differential Equations** **3 Hours**  
Introduction to mathematical modeling with differential equations. First-order differential equations and initial-value problems; graphical solutions via slope fields; numerical solutions via Euler's method; analytic solutions for separable and linear equations. First-order systems with graphical, analytic and numerical solution techniques. Modeling with first-order systems. Linear systems with graphical and analytic solutions; second-order equations via linear systems. Other topics selected from nonlinear systems, Laplace transforms and advanced numerical methods.  
**Prerequisite:** MATH 231.
- 241. Linear Algebra** **3 Hours**  
Systems of equations; matrices; properties of matrices; determinants; vectors

and vector spaces; linear independence; basis; dimension; linear transformations; matrix representation of a linear transformation; eigenvalues; eigenvectors.

**Prerequisite:** MATH 132.

**252. Mathematical Statistics 3 Hours**

Probability; Descriptive statistics; sampling distributions; theory of estimation; confidence intervals; hypothesis testing; linear correlation; chi-square.

**Prerequisite:** MATH 231.

**281. Math for Teachers: Content & Pedagogy 3 Hours**

This course is designed to review elementary math content and promote a shift in the focus of the student from learner to instructor. It will act as bridge from previously learned content to current forms of pedagogical approaches which will be necessary for success in the elementary instructional environment. Various modeling techniques, modes of explanation and facets of description will be discussed. Emphasis will be placed on the understanding and creation of a learning community which will promote critical thinking and collaborative problem solving skills.

**282. Mathematics for Teachers II 3 Hours**

This course is designed to acquaint the student with modern geometry as applied to the elementary school classroom, a study of the metric system and an introduction to probability and statistics.

**321. Numerical Analysis 3 Hours**

This course investigates algorithms for numerical solutions to mathematical problems. Topics drawn from power series, roots of equations, linear and nonlinear systems, numerical differentiation and integration, differential equations, interpolation and difference equations and curve fitting. Most algorithms will be tested on a computer.

**Prerequisites:** CPSC 121, MATH 231.

**331. Modern Geometry 3 Hours**

Historical and formal development of Euclidean and non-Euclidean geometry; role of axiomatic systems; incidence geometry; Hilbert's axioms; neutral

geometry; history of the parallel postulate; philosophical implications.

**Prerequisite:** MATH 131.

**341. Abstract Algebra I 3 Hours**

Introduction to the theory of groups and rings. Symmetries; multiplication of symmetries; symmetries using matrices; isometries. Groups; permutation groups; subgroups; cyclic groups; the dihedral groups. Homomorphisms and isomorphisms; cosets and Lagrange's Theorem; equivalence relations and partitions; the homomorphism theorems; quotient groups; direct and semidirect products. Group actions on sets and finite abelian groups. Rings; polynomial divisibility; integral domains; Euclidean domains; irreducibility.

**Prerequisite:** MATH 241.

**342. Abstract Algebra II 3 Hours**

Further study in the theory of rings and fields. Rings of polynomials. Fields and field extensions; splitting fields of cubic and other polynomials; finite and algebraic field extensions; splitting fields and automorphisms. Topics from isometry groups, symmetries of polyhedra, cryptology and other applications.

**Prerequisite:** MATH 341.

**361. Real Analysis I 3 Hours**

Rigorous treatment of fundamentals of single variable calculus: limits; continuity; differentiation; convergence of series and sequences; and integration.

**Prerequisites:** MATH 231, MATH 241.

**362. Real Analysis II 3 Hours**

Vector calculus in Euclidean space; Jacobians; implicit function theorem; inverse function theorem; integration.

**Prerequisite:** MATH 361.

**412. Topology 3 Hours**

Set theory; metric spaces; topological spaces; continuous mappings; product spaces; quotient spaces; compactness; connectedness; and separation.

**Prerequisites:** MATH 341, MATH 361.

**481. Independent Study in Mathematics 1-4 Hours**

An opportunity for a mathematics major to engage in independent study or research. May be repeated for credit.