OFFICE OF CHIEF ACADEMIC OFFICER
Summary of State Board of Education Agenda Items
Consent Agenda
November 7, 2019

OFFICE OF CAREER AND TECHNICAL EDUCATION

E. Approval to begin the Administrative Procedures Act process: To establish Mississippi Secondary Curriculum Framework in Career and Technical Education – Naval Architecture and Marine Engineering, Shipbuilding Academy

Executive Summary

The Shipbuilding Academy is designed as a secondary program for preparation to enter the field of shipbuilding. The framework incudes an introduction to the basics of construction, manufacturing, and shipbuilding practices. The purpose of the program is to prepare students to continue study in a postsecondary program – welding or other manufacturing trades – or to begin work at the entry level in a shipbuilding-related occupation. Beginning units are written to National Center for Construction Education and Research (NCCER) certification standards.

The shipbuilding industry is a specialized field that focuses on the construction and maintenance of various types of marine vessels. Individuals entering this profession can choose from several areas including cruise ships, navy ships, bulk carriers, tankers, and small offshore vessels.

All curricula frameworks are designed to provide local programs with an instructional foundation that can be used to develop localized instructional management plans and course syllabi. Additionally, the frameworks include the following elements for each secondary curriculum:

- Program
- Description
- Classification of Instructional Program (CIP) Code and CIP Name
- Course Outline and Codes
  - Curriculum
  - Student Competencies
  - Suggested Student Objectives

Recommendation: Approval

Back-up material attached

Mississippi Secondary Curriculum Frameworks in Career and Technical Education, Manufacturing

2020 Shipbuilding Academy

Program CIP: 14.2201- Naval Architecture and Marine Engineering.

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The Research and Curriculum Unit (RCU), located in Starkville, as part of Mississippi State University (MSU), was established to foster educational enhancements and innovations. In keeping with the land-grant mission of MSU, the RCU is dedicated to improving the quality of life for Mississippians. The RCU enhances intellectual and professional development of Mississippi students and educators while applying knowledge and educational research to the lives of the people of the state. The RCU works within the contexts of curriculum development and revision, research, assessment, professional development, and industrial training.

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Acknowledgments

The shipbuilding academy curriculum is being presented to the Mississippi State Board of Education on November 7, 2019. The following persons are serving on the State Board at this time:

Dr. Carey M. Wright, state superintendent of education
Dr. Jason S. Dean, chair
Mr. Buddy Bailey, vice chair
Ms. Rosemary G. Aultman
Dr. Karen J. Elam
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Ms. Brittany Rye
Mr. Sean Suggs
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Mr. Omar G. Jamil, Student Representative

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Brad Skelton, curriculum manager for the RCU, researched and facilitated the development of this framework. bradley.skelton@rcu.msstate.edu

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Victoria Hunt, manager, Ingalls Shipbuilder Academy
Beth Worsham, instructor, Mississippi Gulf Coast Community College
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Bobby Lamb, manager, Ingalls Apprentice School
Betsey Smith, director, RCU
Melissa Luckett, instructional design specialist, RCU

Standards

Standards and alignment crosswalks are referenced in the appendices. Mississippi's CTE Shipbuilding Academy is aligned to the following standards:

National Center for Construction Education and Research (NCCER) Learning Series Welding Standards

The NCCER developed and published a set of industry standards that are taught nationwide by contractors, associations, construction/manufacturing users, and secondary and postsecondary schools called the NCCER learning series. When developing this set of standards, the NCCER assembled a team of subject matter experts that represented manufacturing companies and schools across the nation. Each committee met several times and combined experts' knowledge and experience to finalize the set of national industry standards.

As a part of the accreditation process, all Mississippi manufacturing instructors will be required to successfully complete the Instructor Certification Training Program. This program ensures that instructors possess a deep knowledge of the content of the standards.

This state-of-the-art curriculum is modeled after the eight Mississippi NCCER Accredited Training and Education Facilities (ATEF). To become an NCCER ATEF program, school districts must meet the following set of guidelines:

- Use the approved curriculum
- All instructors must be NCCER certified
- All completed Form 200s and release forms on all student completions are to be forwarded to the Mississippi Construction Education Foundation (MCEF) for proper approval and, in turn, the MCEF will forward to the NCCER for processing
- Follow NCCER guidelines on test security and performance profiles
- Have an active advisory committee with at least two commercial contractors involved
- Follow the safety practices and Occupational Safety and Health Administration (OSHA) standards used in the classroom and lab areas
- Involve commercial contractors in class presentations or field trips
- All manufacturing programs must be included in the accreditation process
- Show active involvement in student leadership development (e.g., SkillsUSA)
- Provide demonstrated placement into Manufacturing-related occupations and provide timely reports to MCEF

College- and Career-Ready Standards

College- and career-ready standards emphasize critical thinking, teamwork, and problem-solving skills. Students will learn the skills and abilities demanded by the workforce of today and the future. Mississippi adopted *Mississippi College and Career Ready Standards* (*MCCRS*) to provide a consistent, clear understanding of what students are expected to learn and so teachers and parents know what they need to do to help them.
mdek12.org/OAE/college-and-career-readiness-standards

International Society for Technology in Education Standards (ISTE)

iste.org

Framework for 21st Century Learning
In defining 21st-century learning, the Partnership for 21st Century Skills has embraced key themes and skill areas that represent the essential knowledge for the 21st century: global awareness; financial, economic, business and entrepreneurial literacy; civic literacy; health literacy; environmental literacy; learning and innovation skills; information, media, and technology skills; and life and career skills. *21 Framework Definitions* (2015).
p21.org/storage/documents/docs/P21_Framework_Definitions_New_Logo_2015.pdf

Preface

Secondary CTE programs in Mississippi face many challenges resulting from sweeping educational reforms at the national and state levels. Schools and teachers are increasingly being held accountable for providing applied learning activities to every student in the classroom. This accountability is measured through increased requirements for mastery and attainment of competency as documented through both formative and summative assessments. This document provides information, tools, and solutions that will aid students, teachers, and schools in creating and implementing applied, interactive, and innovative lessons. Through best practices, alignment with national standards and certifications, community partnerships, and a hands-on, student-centered concept, educators will be able to truly engage students in meaningful and collaborative learning opportunities.

The courses in this document reflect the statutory requirements as found in Section 37-3-49, *Mississippi Code of 1972*, as amended (Section 37-3-46). In addition, this curriculum reflects guidelines imposed by federal and state mandates (Laws, 1988, Ch. 487, §14; Laws, 1991, Ch. 423, §1; Laws, 1992, Ch. 519, §4 eff. from and after July 1, 1992; Carl D. Perkins Vocational Education Act IV, 2007; and Every Student Succeeds Act, 2015).

Mississippi Teacher Professional Resources

The following are resources for Mississippi teachers:

Curriculum, Assessment, Professional Learning
Program resources can be found at the RCU's website, rcu.msstate.edu.
Learning Management System: An Online Resource
Learning management system information can be found at the RCU's website, under Professional Learning.

Should you need additional instructions, call 662.325.2510.

Executive Summary

Pathway Description
The Shipbuilding Academy is designed as a secondary program for preparation to enter the field of shipbuilding. It includes an introduction to the basics of construction, manufacturing, and shipbuilding practices. The purpose of the program is to prepare students to continue study in a postsecondary program—welding or other manufacturing trades—or to begin work at the entry level in a shipbuilding-related occupation. Beginning units are written to NCCER certification standards.

College, Career, and Certifications
NCCER Learning Series

Grade Level and Class Size Recommendations
It is recommended that students enter this program as a 10th grader. Exceptions to this are a district-level decision based on class size, enrollment numbers, and maturity of student. The classroom/lab is designed to accommodate a maximum of 15 students.

Student Prerequisites
For students to experience success in the program, the following student prerequisites are suggested:

1. C or higher in English (the previous year)
2. C or higher in high school-level math (last course taken or the instructor can specify the level of math instruction needed)
3. Instructor approval and TABE reading score (eighth grade or higher)

or

1. TABE reading and math score (eighth grade or higher)
2. Instructor approval

or

1. Instructor approval

Assessment
The latest assessment blueprint for the curriculum can be found at rcu.msstate.edu/curriculum/curriculumdownload.

Applied Academic Credit
The latest academic credit information can be found at mdek12.org/ese/approved-course-for-the-secondary-schools.

Teacher Licensure
The latest CTE teacher licensure information can be found at mdek12.org/otl/oel/career&technical. **Professional Learning**
If you have specific questions about the content of any of training sessions provided, please contact the RCU at 662.325.2510.

Course Outlines

Option 1A—Two 1-Carnegie Unit Courses

This curriculum consists of two 1-credit courses, which should be completed in the following sequence:

1. **Shipbuilding Core—Course Code: Insert number here**
2. **Shipbuilder Exploration—Course Code: Insert number here**

Shipbuilding Core—Course Code: Insert number here

Unit	Title	Hours
1	Orientation and Fundamentals of Student Organizations	5
2	Employability Skills	9
3	Communication Skills	8
4	Basic Safety	11
5	Introduction to Construction Math	9
6	Hand and Power Tools	27
7	Introduction to Construction Drawings	9
8	Introduction to Materials Handling and Basic Rigging	13
9	Introduction to Maritime Industry	9
Total		100

Shipbuilder Exploration—Course Code: Insert number here

10	Welding Objectives (NCCER 29101-15 29106-15)	35
11	Sheetmetal Objectives (NCCER 04102-08 04103-08)	17
12	Industrial Coating Objectives (NCCER 69101-09 69103-09)	27
13	Insulation Objectives (NCCER 19101)	18
14	Electrical Objectives (NCCER 26101-14, 26103-14, 26106-14)	20
15	Support Craft Objectives (NCCER 84101-13, 85106-13, 86104-14, 15101-06, 15302-08, 85101-13, 85206-13)	15
Total		132

Option 1B—One 2-Carnegie Unit Course

This curriculum consists of one 2-credit course.

Shipbuilder I—Course Code: Insert number here

Unit	Title	Hours
1	Orientation and Fundamentals of Student Organizations	5
2	Employability Skills	9
3	Communication Skills	8
4	Basic Safety	11
5	Introduction to Construction Math	9
6	Hand and Power Tools	27
7	Introduction to Construction Drawings	9
8	Introduction to Materials Handling and Basic Rigging	13
9	Introduction to Maritime Industry	9
10	Welding Objectives (NCCER 29101-15 29106-15)	35
11	Sheetmetal Objectives (NCCER 04102-08 04103-08)	17
12	Industrial Coating Objectives (NCCER 69101-09 69103-09)	27
13	Insulation Objectives (NCCER 19101)	18
14	Electrical Objectives (NCCER 26101-14, 26103-14, 26106-14)	20
15	Support Craft Objectives (NCCER 84101-13, 85106-13, 86104-14, 15101-06, 15302-08, 85101-13, 85206-13)	15
Total		232

Option 2A—Two 1-Carnegie Unit Courses
This curriculum consists of two 1-credit courses, which should be completed in the following sequence:

1. **Naval Architecture Core—Course Code: Insert number here**
2. **Shipbuilder Exploration—Course Code: Insert number here**

Naval Architecture Core—Course Code: Insert number here

Unit	Title	Hours
1	Introduction to Shipbuilding and Blueprint Reading	9
2	Ship Construction and Structure	72
3	Shipbuilding Project	19
Total		100

Shipbuilder Exploration—Course Code: Insert number here

Unit	Title	Hours
4	Welding Objectives (NCCER 29101-15 29106-15)	35
5	Sheetmetal Objectives (NCCER 04102-08 04103-08)	17
6	Industrial Coating Objectives (NCCER 69101-09 69103-09)	27
7	Insulation Objectives (NCCER 19101)	18
8	Electrical Objectives (NCCER 26101-14, 26103-14, 26106-14)	20
9	Support Craft Objectives (NCCER 84101-13, 85106-13, 86104-14, 15101-06, 15302-08, 85101-13, 85206-13)	15
Total		132

Option 2B—One 2-Carnegie Unit Course
This curriculum consists of a 1-credit course.

Naval Architecture I—Course Code: Insert number here

Unit	Title	Hours
1	Introduction to Shipbuilding and Blueprint Reading	9
2	Ship Construction and Structure	72
3	Shipbuilding Project	19
4	Welding Objectives (NCCER 29101-15 29106-15)	35
5	Sheetmetal Objectives (NCCER 04102-08 04103-08)	17
6	Industrial Coating Objectives (NCCER 69101-09 69103-09)	27
7	Insulation Objectives (NCCER 19101)	18
8	Electrical Objectives (NCCER 26101-14, 26103-14, 26106-14)	20
9	Support Craft Objectives (NCCER 84101-13, 85106-13, 86104-14, 15101-06, 15302-08, 85101-13, 85206-13)	15
Total		232

Research Synopsis

Introduction

The shipbuilding industry is a specialized field that focuses on the construction and maintenance of various types of marine vessels. Individuals entering this profession can choose from several areas including cruise ships, navy ships, bulk carriers, tankers, and small offshore vessels.

Needs of the Future Workforce

Data for this synopsis were compiled from the Mississippi Department of Employment Security (2019). Employment opportunities for each of the occupations listed below are:

Table 1.1: Current and Projected Occupation Report

	Employment		Projected Growth 2016-2026			Average Wage 2019	
Occupation	Current (2016)	Projected (2026)	Number	Percent	Total Projected Avg. Annual Job Openings	Hourly	Annual
Structural Metal Fabricators and Fitters	810	730	(80)	(9.9)	75	$17.50	$36,390
Sheet Metal Workers	1,030	1,090	60	5.8	115	$19.32	40,180
Welders, Cutters, Solderers, and Brazers	5,490	6,050	560	10.2	660	$21.32	$44,350
Marine Engineers and Naval Architects	320	350	30	18.8%	165	$51.02	$106, 130
Millwright	1,270	1,390	120	9.5	130	$20.83	$43,330
Insulation Workers, Mechanical	440	450	10	2.3%	50		
Tank Car, Truck, and Ship Loaders	190	210	202.3%	10.5%	30	$19.70	$40,970
Operating Engineers and Other Construction Equipment Operators	2,440	2,550	110	4.5%	280	$18.42	$38,310
Plumbers, Pipefitters, and Steamfitters	3,810	4,150	340	8.9%	445	$21.77	$45,280
Riggers	210	220	10	4.8%	25	$21.59	$44,900
Coating, Painting, and Spraying Machine Setters, Operators, and Tenders	960	1,040	60	6.1%	110	$16.53	$34,380
Construction Managers	1,270	1,340	70	5.5%	95	$38.16	$79,380

Perkins IV Requirements
The Shipbuilding Academy curriculum meets Perkins IV requirements of introducing students to and preparing them for high-skill, high-wage occupations. Additionally, the curriculum is integrated with academic standards. Lastly, it focuses on ongoing and meaningful professional development for teachers as well as relationships with industry.

Curriculum Content
The standards to be included in the shipbuilding academy curriculum are the Common Core Standards for Mathematics and Science, 21st Century Skills, and the National Educational Technology Standards (NETS) for Students. Combining these standards to create this document will result in high-skilled, well-rounded students who are prepared to enter a secondary academic or career and technical program of study. They will also be prepared to academically compete nationally as the Common Core Standards are designed to prep students for success in community colleges, institutions of higher learning, and careers.

Industry Certification
The shipbuilding academy curriculum is written to the NCCER Learning Series Standards—Core. Students who successfully complete the units within this curriculum could earn NCCER credentials.

Transition to Postsecondary Education
The latest articulation information for secondary to postsecondary can be found at the Mississippi Community College Board website, mccb.edu.

Best Practices

Differentiated Instruction

Students learn in a variety of ways, and numerous factors—students' background, emotional health, and circumstances—create unique learners. By providing various teaching and assessment strategies, students with various learning preferences can have more opportunity to succeed.

CTE Student Organizations

Teachers should investigate opportunities to sponsor a student organization. There are several here in Mississippi that will foster the types of learning expected from the Shipbuilding Academy curriculum. SkillsUSA is the student's organization for metal fabrication. SkillsUSA provides students with growth opportunities and competitive events. It also opens the doors to the world of manufacturing and scholarships opportunities.

Cooperative Learning

Cooperative learning can help students understand topics when independent learning cannot. Therefore, you will see several opportunities in the Shipbuilding Academy curriculum for group work. To function in today's workforce, students need to be able to work collaboratively with others and solve problems without excessive conflict. The Shipbuilding Academy curriculum provides opportunities for students to work together and help each other to complete complex tasks.

Professional Organizations

Association for Career and Technical Education (ACTE)
acteonline.org

National Center for Construction Education and Research (NCCER)
nccer.org

SkillsUSA—Mississippi
mdek12.org/cte/so/skillsusa

SkillsUSA—National
skillsusa.org

Using This Document

Suggested Time on Task
This section indicates an estimated number of clock hours of instruction that should be required to teach the competencies and objectives of the unit. A minimum of 140 hours of instruction is required for each Carnegie unit credit. The curriculum framework should account for approximately 75-80% of the time in the course. The remaining percentage of class time will include instruction in nontested material, review for end-of-course testing, and special projects.

Competencies and Suggested Objectives
A competency represents a general concept or performance that students are expected to master as a requirement for satisfactorily completing a unit. Students will be expected to receive instruction on all competencies. The suggested objectives represent the enabling and supporting knowledge and performances that will indicate mastery of the competency at the course level.

Integrated Academic Topics, 21st Century Skills and Information and Communication Technology Literacy Standards, ACT College Readiness Standards, and Technology Standards for Students
This section identifies related academic topics as required in the Subject Area Testing Program in Algebra I, Biology I, English II, and U.S. History from 1877, which are integrated into the content of the unit. Research-based teaching strategies also incorporate ACT College Readiness standards. This section also identifies the *21st Century Skills and Information and Communication Technology Literacy* skills. In addition, national technology standards for students associated with the competencies and suggested objectives for the unit are also identified.

References
A list of suggested references is provided for each unit within the accompanying teacher resource document. The list includes some of the primary instructional resources that may be used to teach the competencies and suggested objectives. Again, these resources are suggested, and the list may be modified or enhanced based on needs and abilities of students and on available resources. The teacher resource document can be downloaded at rcu.msstate.edu/Curriculum/CurriculumDownload.aspx.

Enrichment Material
Many of the units include an enrichment section at the end. This section of material will not be tested on the Mississippi Career Planning and Assessment System (MS-CPAS), however it will greatly enhance the learning experiences for the students. It is suggested to use the enrichment material when needed or desired by the teacher and if time allows in the class.

Core Track

Unit 1: Orientation and Student Organizations

Competencies and Suggested Objectives
1. Describe local program and center expectations, policies, and procedures. DOK 1 a. Describe local program and career center policies and procedures, including dress code, attendance, academic requirements, discipline, shop/lab rules and regulations, and transportation regulations. b. Give a brief overview of the course. Explain what construction technology is, why it is important, and how it will be delivered. c. Compare and contrast local program and school policies to expectations of employers. d. Preview course objectives, program policy, and industry standards.
2. Explore work-based learning opportunities related to program areas. DOK 1 a. Define work-based learning. b. Explore the opportunities available through program areas. • Career Pathway Experience (CPE) • Job shadowing • Apprenticeship programs • On-the-job training
3. Discuss the history, mission, and purpose of student organizations, including SkillsUSA. DOK 1 a. Trace the history of the program area's student organization. b. Identify the mission, purpose, and goals of the program area's student organization.
4. Explore the advantages of membership in a student organization. DOK 1 a. Discuss the membership process for the program area's student organization. b. Explain the activities related to the local chapter and the state and national organizations.
5. Discuss the organization's brand resources. DOK 1 a. Identify the motto, creed, and/or pledge and discuss their meanings. b. Recognize related brand resources. • Emblems • Colors • Official attire • Logos • Graphic standards
6. Describe the importance of effective communication skills. DOK 1 a. Demonstrate verbal and nonverbal communication skills. b. Apply appropriate speaking listening skills to class- and work-related situations.
7. Apply leadership skills to class- and work-related situations and 21st century skills. DOK 2 a. Define leadership. b. Discuss the attributes of a leader. c. Identify the roles a leader can assume.

8. Utilize teambuilding skills in class- and work-related situations. DOK 2 a. Define teambuilding. b. Discuss the attributes of a team. c. Identify the roles included in a team.
9. Discuss the various competitions offered through the program area's student organization. DOK 1 a. Describe each of the competitions and the skills needed to accomplish the tasks. b. Perform the tasks needed to complete an assigned requirement for a competition.
Note: This unit will be ongoing throughout the year. Time allotted for this unit will be distributed over the entire year.

Unit 2: Employability Skills

Competencies and Suggested Objectives
1. Describe employment opportunities in the construction industry. DOK 1 a. Describe employment opportunities, including potential earnings, employee benefits, job availability, working conditions, educational requirements, required technology skills, and continuing education/training. b. Discuss the guidelines for developing a proper résumé. c. Demonstrate completing job applications.
2. Examine the Mississippi Department of Employment Security (MDES) website and its applications relating to employment opportunities. DOK 1 a. Perform various searches through the MDES website for specific information, including the number of jobs available for a specific area of expertise, hourly wages, percent of jobs in the county, and percent of jobs in the state.
3. Demonstrate appropriate interviewing skills. DOK 1 a. Identify good interviewing skills and traits, such as speaking, professionalism, and punctuality. b. Simulate a job interview.
4. Describe basic employee responsibilities and appropriate work ethics. DOK 1 a. Compare and contrast employment responsibilities and expectations to local school and program policies and expectations. b. Define effective relationship skills and workplace issues, including but not limited to sexual harassment, stress, and substance abuse.

Unit 3: Communication Skills

Competencies and Suggested Objectives
1. Demonstrate the ability to follow verbal and written instructions and communicate effectively in on-the-job situations. DOK 2 a. Follow basic written and verbal instructions. b. Effectively communicate in on-the-job situations using verbal, written, or electronic communication.
2. Discuss the importance of good listening skills in on-the-job situations. DOK 2 a. Apply the tips for developing good listening skills.

Unit 4: Basic Safety

Competencies and Suggested Objectives
1. Describe, define, and illustrate general safety rules for working in a shop/lab and how they relate to the construction industry. DOK 2 a. Describe how to avoid on-site accidents. b. Explain the relationship between housekeeping and safety. c. Explain the importance of following all safety rules and company safety policies according to OSHA standards. d. Explain the importance of reporting all on-the-job injuries, accidents, and near misses. e. Explain the need for evacuation policies and the importance of following them. f. Explain causes of accidents and the impact of accident costs. g. Compare and contrast shop/lab safety rules to industry safety rules.
2. Identify and apply safety around welding operations. DOK 1 a. Use proper safety practices when welding or working around welding operations. b. Use proper safety practices when welding in or near trenches and excavations. c. Explain proximity work.
3. Display appropriate safety precautions to take around common jobsite hazards. DOK 1 a. Explain the safety requirements for working in confined areas. b. Explain the different barriers and barricades and how they are used.
4. Demonstrate the appropriate use and care of personal protective equipment (PPE). DOK 1 a. Identify commonly used PPE items. b. Understand the proper use of PPE. c. Demonstrate appropriate care for PPE.
5. Explain fall protection, ladder, stair, and scaffold procedures and requirements. DOK 1 a. Explain the use of proper fall protection. b. Inspect and safely work with various ladders, stairs, and scaffolds.
6. Explain the safety data sheet (SDS). DOK 1 a. Explain the function of the SDS. b. Interpret the requirements of the SDS. c. Discuss hazardous material exposures.
7. Display appropriate safety procedures related to fires. DOK 1 a. Explain the process by which fires start. b. Explain fire prevention of various flammable liquids. c. Explain the classes of fire and the types of extinguishers. d. Illustrate the proper steps to follow when using a fire extinguisher. e. Demonstrate the proper techniques for putting out a fire.
8. Explain safety in and around electrical situations. DOK 1 a. Explain injuries that can result when electrical contact occurs. b. Explain safety around electrical hazards. c. Explain action to take when an electrical shock occurs.
Note: Safety is to be taught as an ongoing part of the program. Students are required to complete a written safety test with 100% accuracy before entering the shop for lab simulations and projects. This test should be documented in each student's file.

Unit 5: Introduction to Construction Math

Competencies and Suggested Objectives
1. Apply the four basic math skills using whole numbers, fractions, decimals, and percentages, both with and without a calculator. DOK 2 a. Define basic geometric shapes used in the construction industry. b. Add, subtract, multiply, and divide whole numbers, decimals, and fractions with and without a calculator. c. Convert whole numbers to fractions and convert fractions to whole numbers. d. Convert decimals to percentages and convert percentages to decimals. e. Convert fractions to decimals. f. Convert fractions to percentages. g. Demonstrate reading a standard and metric ruler and tape measure. h. Recognize and use metric units of length, weight, volume, and temperature.

Unit 6: Hand and Power Tools

Competencies and Suggested Objectives
1. Demonstrate the use and maintenance of hand and power tools. DOK 2 a. Identify, visually inspect, and discuss the safe use of common hand and power tools. b. Discuss rules of safety. c. Select and demonstrate the use of tools. d. Explain the procedures for maintenance.

Unit 7: Introduction to Construction Drawings

Competencies and Suggested Objectives
1. Read, analyze, and understand basic components of a blueprint. DOK 3 a. Recognize and identify terms, components, and symbols commonly used on blueprints. b. Relate information on construction drawings to actual locations on the print. c. Recognize different type of drawings. d. Interpret and use drawing dimensions.

Unit 8: Introduction to Materials Handling and Basic Rigging

Competencies and Suggested Objectives
1. Safely handle and store materials. [DOK 1] a. Define a load. b. Establish a pretask plan prior to moving a load. c. Demonstrate proper materials-handling techniques. d. Choose appropriate materials-handling equipment for the task. e. Recognize hazards and follow safety procedures required for materials handling. f. Identify and demonstrate commonly used knots.

Unit 9: Introduction to Maritime Industry

Competencies and Suggested Objectives
1. Explore the maritime industry and common shipbuilding terminology. DOK 1 a. Maritime industry overview • Shipbuilding and repair industry • Shipyards • Docking and launching facilities • Ship repair yards b. Shipbuilding terms • Ship locations and directions • Ship components • Reference lines • Work activities
2. Examine the shipbuilding process and different construction methods utilized in shipbuilding. DOK 2 a. The shipbuilding process b. Design c. Procurement d. Fabrication e. Painting f. Outfitting g. Erection h. Testing and delivery
3. Examine career opportunities in shipbuilding. DOK 1
4. Identify and examine regulatory agencies and organizations. DOK 1 a. OSHA b. Environmental Protection Agency (EPA) c. Classification societies d. U.S. Navy e. U.S. Coast Guard
5. Identify and properly use shipyard safety equipment and procedures. DOK 1 a. Protective clothing and equipment b. Lockout/tagout c. Confined spaces d. Fire hazards e. Slip, trip, and fall hazards f. Hot work hazards g. Asbestos h. Hazardous material labeling
6. Examine common ship construction drawings. DOK 1
7. Identify the process involved in becoming an apprentice and apprentice training practices. DOK 1

Unit 10: Welding Objectives (NCCER 29101-15 29106-15)

Competencies and Suggested Objectives
1. Identify, describe, and demonstrate the safety responsibilities for the various crafts and various career opportunities for those crafts introduced in Shipbuilder Academy. DOK 1
2. Explore basic welding processes. DOK 2 a. Describe basic welding processes, the welding trade, and training programs. b. Describe NCCER standardized training and the apprentice programs. c. Identify personal PPE related to the welding trade. d. Describe the importance of welding safety and identify hazards of environments. e. Describe basic welding safety practices related to general work area. f. Describe hot work permits and fire watch requirements. g. Describe confined spaces and their related safety practices. h. Identify and describe respiratory hazards, equipment, and ways to ventilate welding work areas. i. Explain the purpose of the SDS/material safety data sheet (MSDS) and how it is used. j. Identify and describe the various code organizations that apply to welding and their basic elements. k. Identify and describe all weld discontinuities and their causes. l. Describe various nondestructive and destructive weld exam practices. m. Describe the welder performance testing process including the qualification test to meet the American Welding Society (AWS) and American Society of Mechanical Engineers (ASME) requirements. n. Describe the process for completing a weld test.

Unit 11: Sheet metal Objectives (NCCER 04102-08 04103-08)

Competencies and Suggested Objectives
1. Explore sheet metal procedures and processes. DOK 2 a. Identify and describe the proper use of tools commonly used in the sheet metal trade. b. Describe poor maintenance producers for tools, safety, and usage of tools for sheet metal. c. Identify layout terms, marking tools, and forming tools for the sheet metal craft. d. Identify and explain the three development methods for laying out sheet metal patterns. e. Demonstrate how to select and use forming tools, hand snips, hacksaws, and squaring shears for cutting out parts and patterns. f. Demonstrate how to construct seams, edges, and duct connectors.

Unit 12: Industrial Coating Objectives (NCCER 69101-09 69103-09)

Competencies and Suggested Objectives
1. Explore industrial coating processes and procedures. DOK 2 a. Define the composition and purpose of different industrial coatings. b. Discuss the cause of premature failure coating. c. Define and list the components of process control. d. Define quality control and quality assurance. e. State the purpose of preparing test sections for demonstration processes. f. Explain some of the preparation and application methods and how some coatings are used. g. State the purpose of teaching coating components. h. List the physical properties of paint and coating additives. i. State the purpose for solvents (thinners) in cleaning. j. State the difference between convertible and nonconvertible coating. k. List curing mechanisms for coating. l. Identify conditions that must be considered before selecting a coating/lining. m. Describe the coverage of coatings and learn to calculate wet-dry film thickness. n. Locate and practice safety procedures listed on the MSDS. o. Describe disposal techniques for hazardous and nonhazardous waste.

Unit 13: Insulation Objectives (NCCER 19101)

Competencies and Suggested Objectives
1. Explore insulation processes and procedures. DOK 2 a. Explain what insulation is and the basic used of insulation. b. Understand the history of insulation. c. Identify tools, material, and systems and their uses. d. Explain what an estimate is and how it is used in projects. e. Explain the difference between commercial and industrial plants. f. Explain what energy conservation is. g. Explain who subcontractors, general contractors, and owners are.

Unit 14: Electrical Objectives (NCCER 26101-14, 26103-14, 26106-14)

Competencies and Suggested Objectives
1. Explore electrical principles and applications. DOK 2 a. Define the various sectors of electrical industry. b. Define voltage and how it can be produced. c. Explain the differences between conductors and insulators. d. Define the units of measurement in voltage, current, and resistance. e. Explain the basic characteristics of series and parallel circuits. f. Describe the differences between nonmetallic and metallic boxes. g. Calculate the National Electrical Code (NEC) fill requirement for boxes with volumes less than 100 cubic inches. h. Identify the appropriate box type and size for a given application. i. Select and demonstrate the appropriate method for mounting a given box.

Unit 15: Support Craft Objectives (NCCER 84101-13, 85106-13, 86104-14, 15101-06, 15302-08, 85101-13, 85206-13)

Competencies and Suggested Objectives
1. Explore support craft processes and procedure. DOK 2 a. Recognize and identify structural members and calculate their thickness. b. Identify layout tools, fitting tools, and fitting aids used to fit, align, and check plate joints. c. Demonstrate various precision tools of the millwright trade. d. Identify the different types of ladders and scaffolding used on a worksite and the safe use of them. e. Describe how to safely use ladders and scaffolding. f. Identify the types, sizes, and assembly methods for fiberglass pipe and fittings (plastic).

Naval Architecture Track

Unit 1: Introduction to Shipbuilding and Blueprint Reading

1. Develop a basic understanding of the shipbuilding industry. DOK 1 a. Define terms associated with the shipbuilding industry. b. Differentiate between conventional ship construction and modular construction processes. c. Identify and describe the major parts of a ship and discuss their relationship and function. d. Examine computerized methods for lofting of ship drawings.
2. Develop drawings in the shipbuilding industry. DOK 2 a. Compare and contrast the welding and riveting processes as related to shipbuilding. b. Define welding symbols used in ship blueprints. c. Contrast manual and computerized methods for lofting of ship drawings.
3. Use basic drawing equipment and terms used in sketching and making drawings. DOK 1 a. Identify terms, symbols, and lines used in blueprints for various disciplines.
4. Identify blueprints. DOK 2 a. Identify the three basic views of a drawing. b. Identify the various lines used on drawings. c. Interpret dimensions and symbols. d. Interpret general and specific notes on drawings. e. Locate features on drawings.

Unit 2: Ship Construction and Structure

Competencies and Suggested Objectives
1. Explain the basic design of a ship, including the ship dimensions, form, size, or category. DOK 1 a. Explain the progression of design through the three stages. b. Describe the effect waterway restrictions have on the ship's design. c. Discuss the basics of displacement as it applies to a ship. d. Differentiate between lightweight and deadweight and their effects on ship displacement. e. Explain the contract process in purchase of a new vessel.
2. Contrast hull forms of ships from 1940-1970 as compared to modern day ships. DOK 1 a. Describe and distinguish among oil tankers, bulk carriers, car carriers, RO/RO, and container ships. b. Describe modern cargo handling equipment.
3. Explain the purpose of a classification society. DOK 1 a. List the classification societies that are full members of the International Association of Classification Societies (IACS). b. Compare IACS members of Lloyds Register to the American Bureau of Shipping (ABS).
4. Explain the various processes used to make steel. DOK 1 a. Describe the common steel alloys and/or grades of steel used in the defense industry. b. List and define the methods used in heat treating steels. c. Differentiate between steel plates and steel shapes. d. Distinguish between stress and strain as applied during material testing. e. Describe the tensile test and its application to steel shipbuilding. f. Explain the Charpy V Notch test and its purpose.
5. Compare and contrast the stresses ships experience. DOK 2 a. Describe how the weight and buoyancy of a ship applies to the displacement of water. b. Differentiate between hogging and sagging of a ship's hull. c. Describe the application of bending moments in shaping the hull of a ship. d. Identify and differentiate between local and transverse stresses. e. Describe the interrelationship between stresses and strength members within a ship. f. List and explain the structural failures.
6. Explain the welding and cutting processes used in building Department of Defense (DOD) ships. DOK 2 a. Describe the electric arc welding process as it applies to welding electrodes. b. Differentiate among down hand, horizontal vertical, and overhead welding processes. c. Describe the arc welding processes used in shipbuilding. • Flux cored arc welding (FCAW), • Submerged arc welding (SAW), • Tungsten inert gas (TIG) • Metal inert gas (MIG). d. State the purpose of fluxes and shielding gasses used in welding.

7. Describe welding and testing processes of structural steel used in building DOD ships. DOK 1
   a. Describe the gouging process.
   b. Explain a butt welded joint and the types of edge preparations.
   c. Describe the various types of edge preparations and their purpose.
   d. Discuss the butt welded joint, tack welds, backstep, and wandering welding methods.
   e. State the purpose of testing welds.

8. Explain the interaction of the ship drawing office with development of the product model. DOK 1
   a. Explain the different types of plans/drawings including lines and expansion.
   b. Describe the use of computer-aided design and computer-aided manufacturing (CAD/CAM) in developing the ship product model.
   c. Describe the mold loft process.
   d. Discuss the nesting and identification of piece parts as material is cut during construction.

9. Explain the flow of material through a shipyard. DOK 2
   a. Explain how plates and material are handled in the machine shops.
      - Shot blasting process performed in the Wheelabrator
      - Plate profiling machines and methods
      - Planning machines and methods
      - Drilling machines
      - Guillotines/shears
      - Presses/hydraulic
      - Use of plate rolls for rolling shell plate
   b. Discuss the various bending processes.
      - Heat line
      - Frame
      - Cold frame
   c. Describe the use of robotics in shipbuilding.
   d. Explain the plate profiling machines and methods.

10. Describe the process of plate, section preparation, and machining. DOK 2
   a. Compare and contrast prefabrication of modules versus block style of construction including sub-assemblies and unit fabrication.
   b. List and explain the advantages of preoutfitting modules during the construction process.
   c. Describe the ship lift/floating dry dock method used to launch ships.
   d. Explain the purpose of the Engineering Test and System Assurance (ETSA) memo for launching a ship and the ETSA memo stern release handout.

11. Explain prefabrication and launching processes. DOK 2
   e. Describe the general layout of a shipyard.
   f. Explain the flow of materials in constructing a ship.
   g. Describe the ship lift/floating dry dock method used to launch ships.
   a. Summarize the current steps and processes entailed in building ships.

Unit 3: Shipbuilding Project

Competencies and Suggested Objectives
1. Explain and demonstrate the contract process in the procurement of a new vessel. DOK 1 a. Examine the concept, preliminary, and contract design. b. Explore the request for proposal (RFP). c. Demonstrate line drawings and scales. d. Identify progress payments and milestones.
2. Explain and demonstrate the budget process in the contract process. DOK 2 a. Create a labor cost analysis. b. Create master equipment list and material budgeting. c. Examine milestones and profit margins.
3. Discuss and demonstrate the different terminology used in the contract and shipbuilding process. DOK 2 a. Explore ship dimensions, forms, sizes, and categories. b. Create welding and design information for ship production. c. Examine classification society's purpose.

Unit 4: Welding Objectives (NCCER 29101-15 29106-15)

Competencies and Suggested Objectives
1. Identify, describe, and demonstrate the safety responsibilities for the various crafts and various career opportunities for those crafts introduced in Shipbuilder Academy. DOK 1
2. Explore basic welding processes. DOK 2 a. Describe basic welding processes, the welding trade, and training programs. b. Describe NCCER standardized training and the apprentice programs. c. Identify personal PPE related to the welding trade. d. Describe the importance of welding safety and identify hazards of environments. e. Describe basic welding safety practices related to general work area. f. Describe hot work permits and fire watch requirements. g. Describe confined spaces and their related safety practices. h. Identify and describe respiratory hazards, equipment, and ways to ventilate welding work areas. i. Explain the purpose of the SDS and MSDS and how they are used. j. Identify and describe the various code organizations that apply to welding and their basic elements. k. Identify and describe all weld discontinuities and their causes. l. Describe various nondestructive and destructive weld exam practices. m. Describe the welder performance testing process, including the qualification test to meet AWS and ASME requirements. n. Describe the process for completing a weld test.

Unit 5: Sheet metal Objectives (NCCER 04102-08 04103-08)

Competencies and Suggested Objectives
1. Explore sheet metal procedures and processes. DOK 2 a. Identify and describe the proper use of tools commonly used in the sheet metal trade. b. Describe poor maintenance producers for tools, safety, and usage of tools for sheet metal. c. Examine layout terms, marking tools, forming tools for the sheet metal craft. d. Identify and explain the three development methods for laying out sheet metal patterns. e. Demonstrate how to select and use forming tools, hand snips, hacksaws, and squaring shears for cutting out parts and patterns. f. Demonstrate how to construct seams, edges, and duct connectors.

Unit 6: Industrial Coating Objectives (NCCER 69101-09 69103-09)

Competencies and Suggested Objectives
1. Explore industrial coating processes and procedures. [DOK 2] a. Define the composition and purpose of different industrial coatings. b. Discuss the cause of premature failure coating. c. Define and list the components of process control. d. Define quality control and quality assurance. e. State the purpose of preparing test sections for demonstration process. f. Explain some of the preparation and application methods and how some coatings are used. g. State the purpose of teaching coating component. h. List the physical properties of paint and coating additives. i. State the purpose for solvents (thinners) in cleaning. j. State the difference between convertible and nonconvertible coating. k. List curing mechanisms for coating. l. Identify conditions that must be considered before selecting a coating/lining. m. Describe coverage of coating and learn to calculate wet-dry film thickness. n. Locate and practice safety procedures listed on the MSDS. o. Describe disposal techniques for hazardous and nonhazardous waste.

Unit 7: Insulation Objectives (NCCER 19101)

Competencies and Suggested Objectives
1. Explore the insulation process and its procedures. DOK 2
a. Explain what insulation is and the basic use of insulation.
b. Understand the history of insulation.
c. Identify tools, material, and systems and their uses.
d. Explain what an estimate is and how it is used in projects.
e. Explain the difference between commercial and industrial plants.
f. Explain what energy conservation is.
g. Explain who subcontractors, general contractors, and owners are.

Unit 8: Electrical Objectives (NCCER 26101-14, 26103-14, 26106-14)

Competencies and Suggested Objectives
1. Explore electrical principles and applications. DOK 2
a. Define the various sectors of electrical industry.
b. Define voltage and the ways it is produced.
c. Explain the differences between conductors and insulators.
d. Define the units of measurement in voltage, current, and resistance.
e. Explain the basic characteristics of series and parallel circuits.
f. Describe the differences between nonmetallic and metallic boxes.
g. Calculate the NEC fill requirement for boxes with volumes less than 100 cubic inches.
h. Identify the appropriate box type and size for a given application.
i. Select and demonstrate the appropriate method for mounting a given box.

Unit 9: Support Craft Objectives (NCCER 84101-13, 85106-13, 86104-14, 15101-06, 15101-06, 85101-13, 85206-13)

Competencies and Suggested Objectives
1. Explore support craft processes and procedure. DOK 2 a. Recognize and identify structural members and calculate their thickness. b. Identify layout tools, fitting tools, and fitting aids used to fit, align, and check plate joints. c. Demonstrate various precision tools of the millwright trade. d. Identify the different types of ladders and scaffolding used on a work site, and how to safely use them. e. Describe how to safely use ladders and scaffolding. f. Identify the types, sizes, and assembly methods for fiberglass pipe and fittings (plastic).

Student Competency Profile

Student's Name: _____

This record is intended to serve as a method of noting student achievement of the competencies in each unit. It can be duplicated for each student, and it can serve as a cumulative record of competencies achieved in the course.

In the blank before each competency, place the date on which the student mastered the competency.

Core Track		
Unit 1: Orientation and Student Organizations		
	1.	Describe local program and center expectations, policies, and procedures.
	2.	Explore work-based learning opportunities related to program areas.
	3.	Discuss the history, mission, and purpose of student organizations, including SkillsUSA.
	4.	Explore the advantages of membership in a student organization.
	5.	Discuss the organization's brand resources.
	6.	Describe the importance of effective communication skills.
	7.	Apply leadership skills to class- and work-related situations and 21st century skills.
	8.	Utilize teambuilding skills in class- and work-related situations.
	9.	Discuss the various competitions offered through the program area's student organization.
Unit 2: Employability Skills		
	1.	Describe employment opportunities in the construction industry.
	2.	Examine the Mississippi Department of Employment Security (MDES) website and its applications relating to employment opportunities.
	3.	Demonstrate appropriate interviewing skills.
	4.	Describe basic employee responsibilities and appropriate work ethics.
Unit 3: Communication Skills		
	1.	Demonstrate the ability to follow verbal and written instructions and communicate effectively in on-the-job situations.
	2.	Discuss the importance of good listening skills in on-the-job situations.
Unit 4: Basic Safety		
	1.	Describe, define, and illustrate general safety rules for working in a shop/lab and how they relate to the construction industry.
	2.	Identify and apply safety around welding operations.

	3.	Display appropriate safety precautions to take around common jobsite hazards.
	4.	Demonstrate the appropriate use and care of personal protective equipment (PPE).
	5.	Explain fall protection, ladder, stair, and scaffold procedures and requirements.
	6.	Explain the safety data sheet (SDS).
	7.	Display appropriate safety procedures related to fires.
	8.	Explain safety in and around electrical situations.
Unit 5: Introduction to Construction Math		
	1.	Apply the four basic math skills using whole numbers, fractions, decimals, and percentages, both with and without a calculator.
Unit 6: Hand and Power Tools		
	1.	Demonstrate the use and maintenance of hand and power tools.
Unit 7: Introduction to Construction Drawings		
	1.	Read, analyze, and understand basic components of a blueprint.
Unit 8: Introduction to Materials Handling and Rigging		
	1.	Safely handle and store materials.
Unit 9: Introduction to Maritime Industry		
	1.	Explore the maritime industry and common shipbuilding terminology.
	2.	Examine the shipbuilding process and different construction methods utilized in shipbuilding.
	3.	Examine career opportunities in shipbuilding.
	4.	Identify and examine regulatory agencies and organizations.
	5.	Identify and properly use shipyard safety equipment and procedures.
	6.	Examine common ship construction drawings.
	7.	Identify the process involved in becoming an apprentice and apprentice training practices.
Unit 10: Welding Objectives (NCCER 29101-15 29106-15)		
	1.	Identify, describe, and demonstrate the safety responsibilities for the various crafts and various career opportunities for those crafts introduced in Shipbuilder Academy.
	2.	Explore basic welding processes.
Unit 11: Sheet metal Objectives (NCCER 04102-08 04103-08)		
	1.	Explore sheet metal procedures and processes.
Unit 12: Industrial Coating Objectives (NCCER 69101-09 69103-09)		
	1.	Explore industrial coating processes and procedures.

Unit 13: Insulation Objectives (NCCER 19101)		
	1.	Explore insulation processes and procedures.
Unit 14: Electrical Objectives (NCCER 26101-14, 26103-14, 26106-14)		
	1.	Explore electrical processes and procedures.
Unit 15: Support Craft Objectives (NCCER 84101-13, 85106-13, 86104-14, 15101-06, 15302-08, 85101-13, 85206-13)		
	1.	Explore support craft processes and procedures.

Naval Architecture Track		
Unit 1: Introduction to Shipbuilding and Blueprint Reading		
	1.	Develop a basic understanding of the shipbuilding industry.
	2.	Develop drawings in the shipbuilding industry.
	3.	Use the basic drawing equipment and terms used in sketching and making drawings.
	4.	Identify blueprints.
Unit 2: Ship Construction and Structure		
	1.	Explain the basic design of a ship, including the ship dimensions, form, size, or category.
	2.	Contrast hull forms of ships from 1940-1970 as compared to modern ships.
	3.	Explain the purpose of a classification society.
	4.	Explain the various processes used to make steel.
	5.	Compare and contrast the stresses ships experience.
	6.	Explain the welding and cutting processes used in building Department of Defense (DOD) ships.
	7.	Describe welding and testing processes of structural steel used in building DOD ships.
	8.	Explain the interaction of the ship drawing office with development of the product model.
	9.	Explain the flow of material through a shipyard.
	10.	Describe the process of plate, section preparation, and machining.
	11.	Explain the prefabrication and launching processes.
Unit 3: Shipbuilding Project		
	1.	Explain and demonstrate the contract process in the procurement of a new vessel.
	2.	Explain and demonstrate the budget process in the contract process.
	3.	Discuss and demonstrate the different terminology used in the contract and shipbuilding process.

Unit 4: Welding Objectives (NCCER 29101-15 29106-15)		
	1.	Identify, describe, and demonstrate the safety responsibilities for the various crafts and various career opportunities for those crafts introduced in Shipbuilder Academy.
	2.	Explore basic welding processes.
Unit 5: Sheet metal Objectives (NCCER 04102-08 04103-08)		
	1.	Explore sheet metal procedures and processes.
Unit 6: Industrial Coating Objectives (NCCER 69101-09 69103-09)		
	1.	Explore industrial coating processes and procedures.
Unit 7: Insulation Objectives (NCCER 19101)		
	1.	Explore insulation processes and procedures.
Unit 8: Electrical Objectives (NCCER 26101-14, 26103-14, 26106-14)		
	1.	Explore electrical processes and procedures.
Unit 9: Support Craft Objectives (NCCER 84101-13, 85106-13, 86104-14, 15101-06, 15302-08, 85101-13, 85206-13)		
	1.	Explore support craft processes and procedures.

Appendix A: Industry Standards

NCCER Learning Series Standards for the Shipbuilding Academy (taken from the National Center for Construction Education and Research)

Crosswalk for Shipbuilding Academy																
	Units	**Unit 1**	**Unit 2**	**Unit 3**	**Unit 4**	**Unit 5**	**Unit 6**	**Unit 7**	**Unit 8**	**Unit 9**	**Unit 10**	**Unit 11**	**Unit 12**	**Unit 13**	**Unit 14**	**Unit 15**
CORE BSM					X	X	X	X	X	X	X	X	X	X	X	X
ICM						X									X	
IHT						X	X					X		X		X
IPT						X	X					X		X		X
BLU								X		X						
COM		X	X	X	X		X									
EMP		X	X	X												
IMH					X				X					X		
OTT					X			X		X	X		X	X	X	
BFA									X							
HPT						X	X					X		X		X

NCCER Core

BSM – BASIC SAFETY (00101-09)
ICM – INTRODUCTION TO CONSTRUCTION MATH (00102-09)
IHT – INTRODUCTION TO HAND TOOLS (00103-09)
IPT – INTRODUCTION TO POWER TOOLS (00104-09)
BLU – INTRODUCTION TO CONSTRUCTION DRAWINGS (00105-09)
COM – BASIC COMMUNICATION SKILLS (00107-09)
EMP – BASIC EMPLOYABILITY SKILLS (00108-09)
IMH – INTRODUCTION TO MATERIALS HANDLING (00109-09)
LEVEL 1 CARPENTRY

OTT – ORIENTATION TO THE TRADE (27101-06)
BFA – BUILDING MATERIALS, FASTNERS, AND ADHESIVES (27102-06)
HPT – HAND AND POWER TOOLS (27103-06)

Crosswalk for Shipbuilding Academy (Naval Architecture Track)										
	Units	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8	Unit 9
CORE BSM					X	X	X	X	X	X
ICM									X	
IHT						X				X
IPT						X				X
BLU		X								
COM							X			
EMP										
IMH		X	X			X	X	X	X	X
OTT		X	X	X	X	X	X	X	X	X
BFA										
HPT						X	X			X

NCCER Core

BSM – BASIC SAFETY (00101-09)
ICM – INTRODUCTION TO CONSTRUCTION MATH (00102-09)
IHT – INTRODUCTION TO HAND TOOLS (00103-09)
IPT – INTRODUCTION TO POWER TOOLS (00104-09)
BLU – INTRODUCTION TO CONSTRUCTION DRAWINGS (00105-09)
COM – BASIC COMMUNICATION SKILLS (00107-09)
EMP – BASIC EMPLOYABILITY SKILLS (00108-09)
IMH – INTRODUCTION TO MATERIALS HANDLING (00109-09)
LEVEL 1 CARPENTRY

OTT – ORIENTATION TO THE TRADE (27101-06)
BFA – BUILDING MATERIALS, FASTNERS, AND ADHESIVES (27102-06)
HPT – HAND AND POWER TOOLS (27103-06)

Appendix B: 21st Century Skills[1]

21st Century Crosswalk for Shipbuilding Academy																
	Units	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Standards																
CS1																
CS2			X			X										
CS3																
CS4			X		X					X	X					X
CS5					X											
CS6								X	X							
CS7						X		X	X			X	X	X	X	X
CS8		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
CS9		X	X		X			X				X	X	X	X	X
CS10																
CS11			X													
CS12			X													
CS13			X	X	X	X	X	X	X	X	X	X	X	X	X	X
CS14																
CS15																
CS16		X														

CSS1-21st Century Themes

CS1 Global Awareness

1. Using 21st century skills to understand and address global issues
2. Learning from and working collaboratively with individuals representing diverse cultures, religions, and lifestyles in a spirit of mutual respect and open dialogue in personal, work, and community contexts
3. Understanding other nations and cultures, including the use of non-English languages

CS2 Financial, Economic, Business, and Entrepreneurial Literacy

1. Knowing how to make appropriate personal economic choices
2. Understanding the role of the economy in society
3. Using entrepreneurial skills to enhance workplace productivity and career options

CS3 Civic Literacy

1. Participating effectively in civic life through knowing how to stay informed and understanding governmental processes
2. Exercising the rights and obligations of citizenship at local, state, national, and global levels
3. Understanding the local and global implications of civic decisions

[1] *21st century skills.* (n.d.). Washington, DC: Partnership for 21st Century Skills.

CS4 Health Literacy

1. Obtaining, interpreting, and understanding basic health information and services and using such information and services in ways that enhance health
2. Understanding preventive physical and mental health measures, including proper diet, nutrition, exercise, risk avoidance, and stress reduction
3. Using available information to make appropriate health-related decisions
4. Establishing and monitoring personal and family health goals
5. Understanding national and international public health and safety issues

CS5 Environmental Literacy

1. Demonstrate knowledge and understanding of the environment and the circumstances and conditions affecting it, particularly as relates to air, climate, land, food, energy, water, and ecosystems.
2. Demonstrate knowledge and understanding of society's impact on the natural world (e.g., population growth, population development, resource consumption rate, etc.).
3. Investigate and analyze environmental issues, and make accurate conclusions about effective solutions.
4. Take individual and collective action toward addressing environmental challenges (e.g., participating in global actions, designing solutions that inspire action on environmental issues).

CSS2-Learning and Innovation Skills

CS6 Creativity and Innovation

1. Think Creatively
2. Work Creatively with Others
3. Implement Innovations

CS7 Critical Thinking and Problem Solving

1. Reason Effectively
2. Use Systems Thinking
3. Make Judgments and Decisions
4. Solve Problems

CS8 Communication and Collaboration

1. Communicate Clearly
2. Collaborate with Others

CSS3-Information, Media and Technology Skills

CS9 Information Literacy

1. Access and Evaluate Information
2. Use and Manage Information

CS10 Media Literacy

1. Analyze Media
2. Create Media Products

CS11 ICT Literacy

1. Apply Technology Effectively

CSS4-Life and Career Skills

CS12 Flexibility and Adaptability

1. Adapt to change
2. Be Flexible

CS13 Initiative and Self-Direction

1. Manage Goals and Time
2. Work Independently
3. Be Self-directed Learners

CS14 Social and Cross-Cultural Skills

1. Interact Effectively with others
2. Work Effectively in Diverse Teams

CS15 Productivity and Accountability

1. Manage Projects
2. Produce Results

CS16 Leadership and Responsibility

1. Guide and Lead Others
2. Be Responsible to Others

Appendix C: International Society for Technology in Education Standards (ISTE)

ISTE Crosswalk for Shipbuilding Academy

	Units	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Standards																
T1		X	X													
T2																
T3		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
T4																
T5		X				X		X	X							
T6		X		X	X							X	X	X	X	X
T7		X	X													

T1 Empowered Learner
T2 Digital Citizen
T3 Knowledge Constructor
T4 Innovative Designer
T5 Computational Thinker
T6 Creative Communicator
T7 Global Collaborator

T1 Empowered Learner

Students leverage technology to take an active role in choosing, achieving and demonstrating competency in their learning goals, informed by the learning sciences. Students:

a. Articulate and set personal learning goals, develop strategies leveraging technology to achieve them and reflect on the learning process itself to improve learning outcomes.
b. Build networks and customize their learning environments in ways that support the learning process.
c. Use technology to seek feedback that informs and improves their practice and to demonstrate their learning in a variety of ways.
d. Understand the fundamental concepts of technology operations, demonstrate the ability to choose, use and troubleshoot current technologies and are able to transfer their knowledge to explore emerging technologies.

T2 Digital Citizen

Students recognize the rights, responsibilities and opportunities of living, learning and working in an interconnected digital world, and they act and model in ways that are safe, legal and ethical. Students:

a. Cultivate and manage their digital identity and reputation and are aware of the permanence of their actions in the digital world.
b. Engage in positive, safe, legal and ethical behavior when using technology, including social interactions online or when using networked devices.

c. Demonstrate an understanding of and respect for the rights and obligations of using and sharing intellectual property.
d. Manage their personal data to maintain digital privacy and security and are aware of data-collection technology used to track their navigation online.

T3 Knowledge Constructor

Students critically curate a variety of resources using digital tools to construct knowledge, produce creative artifacts and make meaningful learning experiences for themselves and others. Students:

a. Plan and employ effective research strategies to locate information and other resources for their intellectual or creative pursuits.
b. Evaluate the accuracy, perspective, credibility and relevance of information, media, data or other resources.
c. Curate information from digital resources using a variety of tools and methods to create collections of artifacts that demonstrate meaningful connections or conclusions.
d. Build knowledge by actively exploring real-world issues and problems, developing ideas and theories and pursuing answers and solutions.

T4 Innovative Designer

Students use a variety of technologies within a design process to identify and solve problems by creating new, useful or imaginative solutions. Students:

a. Know and use a deliberate design process for generating ideas, testing theories, creating innovative artifacts or solving authentic problems.
b. Select and use digital tools to plan and manage a design process that considers design constraints and calculated risks.
c. Develop, test and refine prototypes as part of a cyclical design process.
d. Exhibit a tolerance for ambiguity, perseverance and the capacity to work with open-ended problems.

T5 Computational Thinker

Students develop and employ strategies for understanding and solving problems in ways that leverage the power of technological methods to develop and test solutions. Students:

a. Formulate problem definitions suited for technology-assisted methods such as data analysis, abstract models and algorithmic thinking in exploring and finding solutions.
b. Collect data or identify relevant data sets, use digital tools to analyze them, and represent data in various ways to facilitate problem-solving and decision-making.
c. Break problems into component parts, extract key information, and develop descriptive models to understand complex systems or facilitate problem-solving.
d. Understand how automation works and use algorithmic thinking to develop a sequence of steps to create and test automated solutions.

T6 Creative Communicator

Students communicate clearly and express themselves creatively for a variety of purposes using the platforms, tools, styles, formats and digital media appropriate to their goals. Students:

a. Choose the appropriate platforms and tools for meeting the desired objectives of their creation or communication.
b. Create original works or responsibly repurpose or remix digital resources into new creations.
c. Communicate complex ideas clearly and effectively by creating or using a variety of digital objects such as visualizations, models or simulations.
d. Publish or present content that customizes the message and medium for their intended audiences.

T7 Global Collaborator

Students use digital tools to broaden their perspectives and enrich their learning by collaborating with others and working effectively in teams locally and globally. Students:

a. Use digital tools to connect with learners from a variety of backgrounds and cultures, engaging with them in ways that broaden mutual understanding and learning.
b. Use collaborative technologies to work with others, including peers, experts or community members, to examine issues and problems from multiple viewpoints.
c. Contribute constructively to project teams, assuming various roles and responsibilities to work effectively toward a common goal.
d. Explore local and global issues and use collaborative technologies to work with others to investigate solutions.

Appendix D: College and Career Ready Standards – Mathematics

Mathematics Crosswalk for Shipbuilding Academy

	Units	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Standards																
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Mathematics Standards

Number and Quantity

Reason quantitatively and use units to solve problems

N-Q.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.*

N-Q.2 Define appropriate quantities for the purpose of descriptive modeling.*

N-Q.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.*

Algebra

Analyze and solve linear equations and pairs of simultaneous linear equations

8.EE.8 Analyze and solve pairs of simultaneous linear equations.

a. Understand that solutions to a system of two linear equations in two variables correspond to points of intersection of their graphs, because points of intersection satisfy both equations simultaneously.

b. Solve systems of two linear equations in two variables algebraically, and estimate solutions by graphing the equations. Solve simple cases by inspection. For example, $3x + 2y = 5$ and $3x + 2y = 6$ have no solution because $3x + 2y$ cannot simultaneously be 5 and 6.

c. Solve real-world and mathematical problems leading to two linear equations in two variables. For example, given coordinates for two pairs of points, determine whether the line through the first pair of points intersects the line through the second pair.

Interpret the structure of expressions

A-SSE.1 Interpret expressions that represent a quantity in terms of its context.*

a. Interpret parts of an expression, such as terms, factors, and coefficients.

b. Interpret complicated expressions by viewing one or more of their parts as a single entity. For example, interpret $P(1+r)n$ as the product of P and a factor not depending on P.

A-SSE.3 Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.*

c. Use the properties of exponents to transform expressions for exponential functions. For example the expression $1.15t$ can be rewritten as $[1.151/12]\ 12t \approx 1.01212t$ to reveal the approximate equivalent monthly interest rate if the annual rate is 15%.

Creating equations that describe numbers or relationships

A-CED.1 Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.*

A-CED.2 Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.*

A-CED.3 Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or non-viable options in a modeling context. For example, represent inequalities describing nutritional and cost constraints on combinations of different foods.*

A-CED.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. For example, rearrange Ohm's law $V = IR$ to highlight resistance R.*

Solve equations and inequalities in one variable

A-REI.3 Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.

Solve systems of equations

A-REI.5 Prove that, given a system of two equations in two variables, replacing one equation by the sum of that equation and a multiple of the other produces a system with the same solutions.

A-REI.6 Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.

Represent and solve equations and inequalities graphically

A-REI.10 Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line).

A-REI.11 Explain why the x-coordinates of the points where the graphs of the equations $y = f(x)$ and $y = g(x)$ intersect are the solutions of the equation $f(x) = g(x)$; find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where $f(x)$ and/or $g(x)$ are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.*

A-REI.12 Graph the solutions to a linear inequality in two variables as a half-plane (excluding the boundary in the case of a strict inequality), and graph the solution set to a system of linear inequalities in two variables as the intersection of the corresponding half-planes.

Functions

Define, evaluate, and compare functions

8.F.1 Understand that a function is a rule that assigns to each input exactly one output. The graph of a function is the set of ordered pairs consisting of an input and the corresponding output. 1

8.F.2 Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a linear function represented by a table of values and a linear function represented by an algebraic expression, determine which function has the greater rate of change.

8.F.3 Interpret the equation $y = mx + b$ as defining a linear function, whose graph is a straight line; give examples of functions that are not linear. For example, the function $A = s2$ giving the area of a square as a function of its side length is not linear because its graph contains the points (1,1), (2,4) and (3,9), which are not on a straight line.

Use functions to model relationships between quantities

8.F.4 Construct a function to model a linear relationship between two quantities. Determine the rate of change and initial value of the function from a description of a relationship or from two (x, y) values, including reading these from a table or from a graph. Interpret the rate of change and initial value of a linear function in terms of the situation it models, and in terms of its graph or a table of values.

8.F.5 Describe qualitatively the functional relationship between two quantities by analyzing a graph (e.g., where the function is increasing or decreasing, linear or nonlinear). Sketch a graph that exhibits the qualitative features of a function that has been described verbally.

Understand the concept of a function and use function notation

F-IF.1 Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then f(x) denotes the output of f corresponding to the input x. The graph of f is the graph of the equation $y = f(x)$.

F-IF.2 Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.

F-IF.3 Recognize that sequences are functions, sometimes defined recursively, whose domain is a subset of the integers. For example, the Fibonacci sequence is defined recursively by $f(0) = f(1) = 1$, $f(n+1) = f(n) + f(n-1)$ for $n \geq 1$.

Interpret functions that arise in applications in terms of the context

F-IF.4 For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Key features include intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative
maximums and minimums; symmetries; end behavior; and periodicity.*

F-IF.5 Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. For example, if the function h(n) gives the number of person-hours it takes to assemble n engines in a factory, then the positive integers would be an appropriate domain for the function.*

F-IF.6 Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.* Analyze functions using different representations Supporting

F-IF.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.* a. Graph linear and quadratic functions and show intercepts, maxima, and minima.

F-IF.9 Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum.

Build a function that models a relationship between two quantities

F-BF.1 Write a function that describes a relationship between two quantities.* a. Determine an explicit expression, a recursive process, or steps for calculation from a context.

F-BF.2 Write arithmetic and geometric sequences both recursively and with an explicit formula, use them to model situations, and translate between the two forms.*

Construct and compare linear, quadratic, and exponential models and solve problems

F-LE.1 Distinguish between situations that can be modeled with linear functions and with exponential functions.*

a. Prove that linear functions grow by equal differences over equal intervals and that exponential functions grow by equal factors over equal intervals.

b. Recognize situations in which one quantity changes at a constant rate per unit interval relative to another.

c. Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another.

F-LE.2 Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table).*

F-LE.3 Observe using graphs and tables that a quantity increasing exponentially eventually exceeds a quantity increasing linearly, quadratically, or (more generally) as a polynomial function.* Interpret expressions for functions in terms of the situation they model Supporting

F-LE.5 Interpret the parameters in a linear or exponential function in terms of a context.*

Geometry

Understand and apply the Pythagorean Theorem

8.G.6 Explain a proof of the Pythagorean Theorem and its converse.

8.G.7 Apply the Pythagorean Theorem to determine unknown side lengths in right triangles in real-world and mathematical problems in two and three dimensions.

8.G.8 Apply the Pythagorean Theorem to find the distance between two points in a coordinate system.

Experiment with transformations in the plane

G-CO.1 Know precise definitions of angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and distance around a circular arc.

G-CO.2 Represent transformations in the plane using, e.g., transparencies and geometry software; describe transformations as functions that take points in the plane as inputs and give other points as outputs. Compare transformations that preserve distance and angle to those that do not (e.g., translation versus horizontal stretch).

G-CO.3 Given a rectangle, parallelogram, trapezoid, or regular polygon, describe the rotations and reflections that carry it onto itself.

G-CO.4 Develop definitions of rotations, reflections, and translations in terms of angles, circles, perpendicular lines, parallel lines, and line segments.

G-CO.5 Given a geometric figure and a rotation, reflection, or translation, draw the transformed figure using, e.g., graph paper, tracing paper, or geometry software. Specify a sequence of transformations that will carry a given figure onto another.

Understand congruence in terms of rigid motions

G-CO.6 Use geometric descriptions of rigid motions to transform figures and to predict the effect of a given rigid motion on a given figure; given two figures, use the definition of congruence in terms of rigid motions to decide if they are congruent.

G-CO.7 Use the definition of congruence in terms of rigid motions to show that two triangles are congruent if and only if corresponding pairs of sides and corresponding pairs of angles are congruent.

G-CO.8 Explain how the criteria for triangle congruence (ASA, SAS, and SSS) follow from the definition of congruence in terms of rigid motions.

Prove geometric theorems

G-CO.9 Prove theorems about lines and angles. Theorems include: vertical angles are congruent; when a transversal crosses parallel lines, alternate interior angles are congruent and corresponding angles are congruent; points on a perpendicular bisector of a line segment are exactly those equidistant from the segment's endpoints.

G-CO.10 Prove theorems about triangles. Theorems include: measures of interior angles of a triangle sum to 180; base angles of isosceles triangles are congruent; the segment joining midpoints of two sides of a triangle is parallel to the third side and half the length; the medians of a triangle meet at a point.

G-CO.11 Prove theorems about parallelograms. Theorems include: opposite sides are congruent, opposite angles are congruent, the diagonals of a parallelogram bisect each other, and conversely, rectangles are parallelograms with congruent diagonals.

Statistics and Probability

Investigate patterns of association in bivariate data

8.SP.1 Construct and interpret scatter plots for bivariate measurement data to investigate patterns of association between two quantities. Describe patterns such as clustering, outliers, positive or negative association, linear association, and nonlinear association.

8.SP.2 Know that straight lines are widely used to model relationships between two quantitative variables. For scatter plots that suggest a linear association, informally fit a straight line, and informally assess the model fit by judging the closeness of the data points to the line.

8.SP.3 Use the equation of a linear model to solve problems in the context of bivariate measurement data, interpreting the slope and intercept. For example, in a linear model for a biology experiment, interpret a slope of 1.5 cm/hr as meaning that an additional hour of sunlight each day is associated with an additional 1.5 cm in mature plant height.

8.SP.4 Understand that patterns of association can also be seen in bivariate categorical data by displaying frequencies and relative frequencies in a two-way table. Construct and interpret a two-way table summarizing data on two categorical variables collected from the same subjects. Use relative frequencies calculated for rows or columns to describe possible association between the two variables. For example, collect data from students in your class on whether or not they have a curfew on school nights and whether or not they have assigned chores at home. Is there evidence that those who have a curfew also tend to have chores?

Summarize, represent, and interpret data on a single count or measurement variable

S-ID.1 Represent data with plots on the real number line (dot plots, histograms, and box plots).*

S-ID.2 Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets.*

S-ID.3 Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers).*

Summarize, represent, and interpret data on two categorical and quantitative variables

S-ID.5 Summarize categorical data for two categories in two-way frequency tables. Interpret relative frequencies in the context of the data (including joint, marginal, and conditional relative frequencies). Recognize possible associations and trends in the data.*

S-ID.6 Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.*

a. Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear, quadratic, and exponential models.

c. Fit a linear function for a scatter plot that suggests a linear association.

Interpret linear models

S-ID.7 Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.*

S-ID.8 Compute (using technology) and interpret the correlation coefficient of a linear fit.*

S-ID.9 Distinguish between correlation and causation.*

Algebra I

Number and Quantity

Use properties of rational and irrational numbers

N-RN.3 Explain why the sum or product of two rational numbers is rational; that the sum of a rational number and an irrational number is irrational; and that the product of a nonzero rational number and an irrational number is irrational.

Reason quantitatively and use units to solve problems

N-Q.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.*

N-Q.2 Define appropriate quantities for the purpose of descriptive modeling.*

N-Q.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.*

Algebra

Interpret the structure of expressions

A-SSE.1 Interpret expressions that represent a quantity in terms of its context.*

a. Interpret parts of an expression, such as terms, factors, and coefficients.

b. Interpret complicated expressions by viewing one or more of their parts as a single entity. For example, interpret P(1+r)n as the product of P and a factor not depending on P.

A-SSE.2 Use the structure of an expression to identify ways to rewrite it. For example, see x4 – y 4 as (x2) 2 – (y2) 2 thus recognizing it as a difference of squares that can be factored as (x2 – y 2) (x2 + y2).

Write expressions in equivalent forms to solve problems

A-SSE.3 Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.*

a. Factor a quadratic expression to reveal the zeros of the function it defines.

b. Complete the square in a quadratic expression to reveal the maximum or minimum value of the function it defines.

c. Use the properties of exponents to transform expressions for exponential functions. For example the expression 1.15t can be rewritten as [1.151/12] 12t ≈ 1.01212t to reveal the approximate equivalent monthly interest rate if the annual rate is 15%.

Algebra I

Perform arithmetic operations on polynomials

A-APR.1 Understand that polynomials form a system analogous to the integers, namely, they are closed under the operations of addition, subtraction, and multiplication; add, subtract, and multiply polynomials.

Understand the relationship between zeros and factors of polynomials

A-APR.3 Identify zeros of polynomials when suitable factorizations are available, and use the zeros to construct a rough graph of the function defined by the polynomial.

Create equations that describe numbers or relationships

A-CED.1 Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.*

A-CED.2 Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.*

A-CED.3 Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or non-viable options in a modeling context. For example, represent inequalities describing nutritional and cost constraints on combinations of different foods.*

A-CED.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. For example, rearrange Ohm's law V = IR to highlight resistance R.*

Understand solving equations as a process of reasoning and explain the reasoning

A-REI.1 Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method.

Solve equations and inequalities in one variable

A-REI.3 Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.

A-REI.4 Solve quadratic equations in one variable.

a. Use the method of completing the square to transform any quadratic equation in x into an equation of the form $(x - p)\ 2 = q$ that has the same solutions. Derive the quadratic formula from this form.

b. Solve quadratic equations by inspection (e.g., for $x\ 2 = 49$), taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions and write them as $a \pm bi$ for real numbers a and b.

Algebra I

Solve systems of equations

A-REI.5 Prove that, given a system of two equations in two variables, replacing one equation by the sum of that equation and a multiple of the other produces a system with the same solutions.

A-REI.6 Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.

Represent and solve equations and inequalities graphically

A-REI.10 Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line).

A-REI.11 Explain why the x-coordinates of the points where the graphs of the equations $y = f(x)$ and $y = g(x)$ intersect are the solutions of the equation $f(x) = g(x)$; find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where $f(x)$ and/or $g(x)$ are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.*

A-REI.12 Graph the solutions to a linear inequality in two variables as a half-plane (excluding the boundary in the case of a strict inequality), and graph the solution set to a system of linear inequalities in two variables as the intersection of the corresponding half-planes.

Functions

Understand the concept of a function and use function notation

F-IF.1 Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then $f(x)$ denotes the output of f corresponding to the input x. The graph of f is the graph of the equation $y = f(x)$.

F-IF.2 Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.

F-IF.3 Recognize that sequences are functions, sometimes defined recursively, whose domain is a subset of the integers. For example, the Fibonacci sequence is defined recursively by $f(0) = f(1) = 1$, $f(n+1) = f(n) + f(n-1)$ for $n \geq 1$

Interpret functions that arise in applications in terms of the context

F-IF.4 For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.*

F-IF.5 Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. For example, if the function h(n) gives the number of person-hours it takes to assemble n engines in a factory, then the positive integers would be an appropriate domain for the function.*

F-IF.6 Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.*

Algebra I

Analyze functions using different representations

F-IF.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.*

a. Graph linear and quadratic functions and show intercepts, maxima, and minima.

b. Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions.

F-IF.8 Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function.

a. Use the process of factoring and completing the square in a quadratic function to show zeros, extreme values, and symmetry of the graph, and interpret these in terms of a context.

F-IF.9 Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum. B

Build a function that models a relationship between two quantities

F-BF.1 Write a function that describes a relationship between two quantities.*

a. Determine an explicit expression, a recursive process, or steps for calculation from a context.

Build new functions from existing functions

F-BF.3 Identify the effect on the graph of replacing f(x) by f(x) + k, k f(x), f(kx), and f(x + k) for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them

Construct and compare linear, quadratic, and exponential models and solve problems

F-LE.1 Distinguish between situations that can be modeled with linear functions and with exponential functions.*

a. Prove that linear functions grow by equal differences over equal intervals and that exponential functions grow by equal factors over equal intervals.

b. Recognize situations in which one quantity changes at a constant rate per unit interval relative to another.

c. Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another.

F-LE.2 Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table).*

F-LE.3 Observe using graphs and tables that a quantity increasing exponentially eventually exceeds a quantity increasing linearly, quadratically, or (more generally) as a polynomial function.*

Algebra I

Interpret expressions for functions in terms of the situation they model

F-LE.5 Interpret the parameters in a linear or exponential function in terms of a context.*

Statistics and Probability *

Summarize, represent, and interpret data on a single count or measurement variable

S-ID.1 Represent data with plots on the real number line (dot plots, histograms, and box plots).*

S-ID.2 Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets.*

S-ID.3 Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers).*

Summarize, represent, and interpret data on two categorical and quantitative variables

S-ID.5 Summarize categorical data for two categories in two-way frequency tables. Interpret relative frequencies in the context of the data (including joint, marginal, and conditional relative frequencies). Recognize possible associations and trends in the data.*

S-ID.6 Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.*

a. Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear, quadratic, and exponential models.

b. Informally assess the fit of a function by plotting and analyzing residuals.

c. Fit a linear function for a scatter plot that suggests a linear association.

Interpret linear models

S-ID.7 Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.*

S-ID.8 Compute (using technology) and interpret the correlation coefficient of a linear fit.*

S-ID.9 Distinguish between correlation and causation.*

Geometry Course

Geometry

Experiment with transformations in the plane

G-CO.1 Know precise definitions of angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and distance around a circular arc.

G-CO.2 Represent transformations in the plane using, e.g., transparencies and geometry software; describe transformations as functions that take points in the plane as inputs and give other points as outputs. Compare transformations that preserve distance and angle to those that do not (e.g., translation versus horizontal stretch).

G-CO.3 Given a rectangle, parallelogram, trapezoid, or regular polygon, describe the rotations and reflections that carry it onto itself.

G-CO.4 Develop definitions of rotations, reflections, and translations in terms of angles, circles, perpendicular lines, parallel lines, and line segments.

G-CO.5 Given a geometric figure and a rotation, reflection, or translation, draw the transformed figure using, e.g., graph paper, tracing paper, or geometry software. Specify a sequence of transformations that will carry a given figure onto another.

Understand congruence in terms of rigid motions

G-CO.6 Use geometric descriptions of rigid motions to transform figures and to predict the effect of a given rigid motion on a given figure; given two figures, use the definition of congruence in terms of rigid motions to decide if they are congruent.

G-CO.7 Use the definition of congruence in terms of rigid motions to show that two triangles are congruent if and only if corresponding pairs of sides and corresponding pairs of angles are congruent.

G-CO.8 Explain how the criteria for triangle congruence (ASA, SAS, and SSS) follow from the definition of congruence in terms of rigid motions.

Prove geometric theorems

G-CO.9 Prove theorems about lines and angles. Theorems include: vertical angles are congruent; when a transversal crosses parallel lines, alternate interior angles are congruent and corresponding angles are congruent; points on a perpendicular bisector of a line segment are exactly those equidistant from the segment's endpoints.

G-CO.10 Prove theorems about triangles. Theorems include: measures of interior angles of a triangle sum to 180; base angles of isosceles triangles are congruent; the segment joining midpoints of two sides of a triangle is parallel to the third side and half the length; the medians of a triangle meet at a point.

G-CO.11 Prove theorems about parallelograms. Theorems include: opposite sides are congruent, opposite angles are congruent, the diagonals of a parallelogram bisect each other, and conversely, rectangles are parallelograms with congruent diagonals.

Geometry Course

Make geometric constructions

G-CO.12 Make formal geometric constructions with a variety of tools and methods (compass and straightedge, string, reflective devices, paper folding, dynamic geometric software, etc.). Copying a segment; copying an angle; bisecting a segment; bisecting an angle; constructing perpendicular lines, including the perpendicular bisector of a line segment; and constructing a line parallel to a given line through a point not on the line.

G-CO.13 Construct an equilateral triangle, a square, and a regular hexagon inscribed in a circle.

Understand similarity in terms of similarity transformations

G-SRT.1 Verify experimentally the properties of dilations given by a center and a scale factor:

a. A dilation takes a line not passing through the center of the dilation to a parallel line, and leaves a line passing through the center unchanged.

b. The dilation of a line segment is longer or shorter in the ratio given by the scale factor.

G-SRT.2 Given two figures, use the definition of similarity in terms of similarity transformations to decide if they are similar; explain using similarity transformations the meaning of similarity for triangles as the equality of all corresponding pairs of angles and the proportionality of all corresponding pairs of sides.

G-SRT.3 Use the properties of similarity transformations to establish the AA criterion for two triangles to be similar.

Prove theorems involving similarity

G-SRT.4 Prove theorems about triangles. Theorems include: a line parallel to one side of a triangle divides the other two proportionally, and conversely; the Pythagorean Theorem proved using triangle similarity.

G-SRT.5 Use congruence and similarity criteria for triangles to solve problems and to prove relationships in geometric figures.

Define trigonometric ratios and solve problems involving right triangles

G-SRT.6 Understand that by similarity, side ratios in right triangles are properties of the angles in the triangle, leading to definitions of trigonometric ratios for acute angles.

G-SRT.7 Explain and use the relationship between the sine and cosine of complementary angles.

G-SRT.8 Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems.*

Understand and apply theorems about circles

G-C.1 Prove that all circles are similar

G-C.2 Identify and describe relationships among inscribed angles, radii, and chords. Include the relationship between central, inscribed, and circumscribed angles; inscribed angles on a diameter are right angles; the radius of a circle is perpendicular to the tangent where the radius intersects the circle.

G-C.3 Construct the inscribed and circumscribed circles of a triangle, and prove properties of angles for a quadrilateral inscribed in a circle.

Find arc lengths and areas of sectors of circles

G-C.5 Derive using similarity the fact that the length of the arc intercepted by an angle is proportional to the radius, and define the radian measure of the angle as the constant of proportionality; derive the formula for the area of a sector.

Translate between the geometric description and the equation for a conic section A

G-GPE.1 Derive the equation of a circle of given center and radius using the Pythagorean Theorem; complete the square to find the center and radius of a circle given by an equation.

Use coordinates to prove simple geometric theorems algebraically

G-GPE.4 Use coordinates to prove simple geometric theorems algebraically. For example, prove or disprove that a figure defined by four given points in the coordinate plane is a rectangle; prove or disprove that the point $(1, \sqrt{3})$ lies on the circle centered at the origin and containing the point (0, 2).

G-GPE.5 Prove the slope criteria for parallel and perpendicular lines and use them to solve geometric problems (e.g., find the equation of a line parallel or perpendicular to a given line that passes through a given point).

G-GPE.6 Find the point on a directed line segment between two given points that partitions the segment in a given ratio.

G-GPE.7 Use coordinates to compute perimeters of polygons and areas of triangles and rectangles, e.g., using the distance formula.*

Explain volume formulas and use them to solve problems

G-GMD.1 Give an informal argument for the formulas for the circumference of a circle, area of a circle, volume of a cylinder, pyramid, and cone. Use dissection arguments, Cavalieri's principle, and informal limit arguments.

G-GMD.3 Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems.*

Visualize relationships between two-dimensional and three-dimensional objects

G-GMD.4 Identify the shapes of two-dimensional cross-sections of three-dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects.

Apply geometric concepts in modeling situations

G-MG.1 Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).*

G-MG.2 Apply concepts of density based on area and volume in modeling situations (e.g., persons per square mile, BTUs per cubic foot).*

G-MG.3 Apply geometric methods to solve design problems (e.g., designing an object or structure to satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios).*

Algebra II

Number and Quantity

Extend the properties of exponents to rational exponents

N-RN.1 Explain how the definition of the meaning of rational exponents follows from extending the properties of integer exponents to those values, allowing for a notation for radicals in terms of rational exponents. For example, we define 51/3 to be the cube root of 5 because we want [51/3] 3 = 5(1/3) 3 to hold, so [51/3] 3 must equal 5.

N-RN.2 Rewrite expressions involving radicals and rational exponents using the properties of exponents.

Reason quantitatively and use units to solve problems

N-Q.2 Define appropriate quantities for the purpose of descriptive modeling.*

Perform arithmetic operations with complex numbers

N-CN.1 Know there is a complex number i such that i 2 = −1, and every complex number has the form a + bi with a and b real.

N-CN.2 Use the relation i 2 = −1 and the commutative, associative, and distributive properties to add, subtract, and multiply complex numbers.

Use complex numbers in polynomial identities and equations

N-CN.7 Solve quadratic equations with real coefficients that have complex solutions.

Algebra

Interpret the structure of expressions

A-SSE.2 Use the structure of an expression to identify ways to rewrite it. For example, see x4 – y 4 as (x2) 2 – (y2) 2, thus recognizing it as a difference of squares that can be factored as (x2 – y 2) (x2 + y2).

Write expressions in equivalent forms to solve problems

A-SSE.3 Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.* c. Use the properties of exponents to transform expressions for exponential functions. For example the expression 1.15t can be rewritten as [1.151/12] 12t ≈ 1.01212t to reveal the approximate equivalent monthly interest rate if the annual rate is 15%.

Algebra II

A-SSE.4 Derive the formula for the sum of a finite geometric series (when the common ratio is not 1), and use the formula to solve problems. For example, calculate mortgage payments.*

Understand the relationship between zeros and factors of polynomials

A-APR.2 Know and apply the Remainder Theorem: For a polynomial p(x) and a number a, the remainder on division by x – a is p(a), so p(a) = 0 if and only if (x – a) is a factor of p(x).

A-APR.3 Identify zeros of polynomials when suitable factorizations are available, and use the zeros to construct a rough graph of the function defined by the polynomial.

Use polynomial identities to solve problems

A-APR.4 Prove polynomial identities and use them to describe numerical relationships. For example, the polynomial identity (x2 + y2) 2 = (x2 – y 2) 2 + (2xy) 2 can be used to generate Pythagorean triples.

Rewrite rational expressions

A-APR.6 Rewrite simple rational expressions in different forms; write a(x)/b(x) in the form q(x) + r(x)/b(x), where a(x), b(x), q(x), and r(x) are polynomials with the degree of r(x) less than the degree of b(x), using inspection, long division, or, for the more complicated examples, a computer algebra system.

Create equations that describe numbers or relationships

A-CED.1 Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.*

Understand solving equations as a process of reasoning and explain the reasoning

A-REI.1 Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method.

A-REI.2 Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise.

Solve equations and inequalities in one variable

A-REI.4 Solve quadratic equations in one variable. b. Solve quadratic equations by inspection (e.g., for x 2 = 49), taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions and write them as a ± bi for real numbers a and b.

Algebra II

Solve systems of equations

A-REI.6 Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.

A-REI.7 Solve a simple system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically. For example, find the points of intersection between the line y = -3x and the circle x2 + y2 = 3.

Represent and solve equations and inequalities graphically

A-REI.11 Explain why the x-coordinates of the points where the graphs of the equations y = f(x) and y = g(x) intersect are the solutions of the equation f(x) = g(x); find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where f(x) and/or g(x) are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.*

Functions

Understand the concept of a function and use function notation

F-IF.3 Recognize that sequences are functions, sometimes defined recursively, whose domain is a subset of the integers. For example, the Fibonacci sequence is defined recursively by f(0) = f(1) = 1, f(n+1) = f(n) + f(n-1) for $n \geq 1$.

Interpret functions that arise in applications in terms of the context

F-IF.4 For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.*

F-IF.6 Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.*

Analyze functions using different representations

F-IF.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.*

c. Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior.

e. Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude.

Algebra II

F-IF.8 Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function.

b. Use the properties of exponents to interpret expressions for exponential functions. For example, identify percent rate of change in functions such as y = (1.02)t , y = (0.97)t , y = (1.01)12t, y = (1.2)t/10, and classify them as representing exponential growth and decay.

F-IF.9 Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum.

Build a function that models a relationship between two quantities

F-BF.1 Write a function that describes a relationship between two quantities.*

a. Determine an explicit expression, a recursive process, or steps for calculation from a context.

b. Combine standard function types using arithmetic operations. For example, build a function that models the temperature of a cooling body by adding a constant function to a decaying exponential, and relate these functions to the model.

F-BF.2 Write arithmetic and geometric sequences both recursively and with an explicit formula, use them to model situations, and translate between the two forms.*

Build new functions from existing functions

F-BF.3 Identify the effect on the graph of replacing f(x) by f(x) + k, k f(x), f(kx), and f(x + k) for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them.

F-BF.4 Find inverse functions. a. Solve an equation of the form f(x) = c for a simple function f that has an inverse and write an expression for the inverse. For example, f(x) =2x 3 or f(x) = (x+1)/(x-1) for $x \neq 1$.

Construct and compare linear, quadratic, and exponential models and solve problems

F-LE.2 Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table).*

F-LE.4 For exponential models, express as a logarithm the solution to abct = d where a, c, and d are numbers and the base b is 2, 10, or e; evaluate the logarithm using technology.*

Interpret expressions for functions in terms of the situation they model

F-LE.5 Interpret the parameters in a linear or exponential function in terms of a context.*

Algebra II

Extend the domain of trigonometric functions using the unit circle

F-TF.1 Understand radian measure of an angle as the length of the arc on the unit circle subtended by the angle.

F-TF.2 Explain how the unit circle in the coordinate plane enables the extension of trigonometric functions to all real numbers, interpreted as radian measures of angles traversed counterclockwise around the unit circle.

Model periodic phenomena with trigonometric functions

F-TF.5 Choose trigonometric functions to model periodic phenomena with specified amplitude, frequency, and midline.*

Prove and apply trigonometric identities

F-TF.8 Prove the Pythagorean identity sin (Θ)2 + cos (Θ)2 = 1 and use it to find sin (Θ), cos (Θ), or tan (Θ), given sin (Θ), cos (Θ), or tan (Θ) and the quadrant of the angle.

Geometry

Translate between the geometric description and the equation for a conic section

G-GPE.2 Derive the equation of a parabola given a focus and directrix.

Statistics and Probability

Summarize, represent, and interpret data on a single count or measurement variable

S-ID.4 Use the mean and standard deviation of a data set to fit it to a normal distribution and to estimate population percentages. Recognize that there are data sets for which such a procedure is not appropriate. Use calculators, spreadsheets, and tables to estimate areas under the normal curve.*

Summarize, represent, and interpret data on two categorical and quantitative variables

S-ID.6 Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.*

a. Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear, quadratic, and exponential models.

Algebra II

Understand and evaluate random processes underlying statistical experiments

S-IC.1 Understand statistics as a process for making inferences about population parameters based on a random sample from that population.*

S-IC.2 Decide if a specified model is consistent with results from a given data-generating process, e.g., using simulation. For example, a model says a spinning coin falls heads up with probability 0.5. Would a result of 5 tails in a row cause you to question the model?*

Make inferences and justify conclusions from sample surveys, experiments, and observational studies

S-IC.3 Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each.*

S-IC.4 Use data from a sample survey to estimate a population mean or proportion; develop a margin of error through the use of simulation models for random sampling.*

S-IC.5 Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant.*

S-IC.6 Evaluate reports based on data.*

Understand independence and conditional probability and use them to interpret data

S-CP.1 Describe events as subsets of a sample space (the set of outcomes) using characteristics (or categories) of the outcomes, or as unions, intersections, or complements of other events ("or," "and," "not").*

S-CP.2 Understand that two events A and B are independent if the probability of A and B occurring together is the product of their probabilities, and use this characterization to determine if they are independent.*

S-CP.3 Understand the conditional probability of A given B as P(A and B)/P(B), and interpret independence of A and B as saying that the conditional probability of A given B is the same as the probability of A, and the conditional probability of B given A is the same as the probability of B.*

S-CP.4 Construct and interpret two-way frequency tables of data when two categories are associated with each object being classified. Use the two-way table as a sample space to decide if events are independent and to approximate conditional probabilities. For example, collect data from a random sample of students in your school on their favorite subject among math, science, and English. Estimate the probability that a randomly selected student from your school will favor science given that the student is in tenth grade. Do the same for other subjects and compare the results.*

S-CP.5 Recognize and explain the concepts of conditional probability and independence in everyday language and everyday situations. For example, compare the chance of having lung cancer if you are a smoker with the chance of being a smoker if you have lung cancer.*

Use the rules of probability to compute probabilities of compound events in a uniform probability model

S-CP.6 Find the conditional probability of A given B as the fraction of B's outcomes that also belong to A, and interpret the answer in terms of the model.*

S-CP.7 Apply the Addition Rule, P(A or B) = P(A) + P(B) – P(A and B), and interpret the answer in terms of the model.*

Integrated Mathematics

Number and Quantity

Reason quantitatively and use units to solve problems

N-Q.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.*

N-Q.2 Define appropriate quantities for the purpose of descriptive modeling.*

N-Q.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.*

Algebra

Interpret the structure of expressions

A-SSE.1 Interpret expressions that represent a quantity in terms of its context.*

a. Interpret parts of an expression, such as terms, factors, and coefficients.

b. Interpret complicated expressions by viewing one or more of their parts as a single entity. For example, interpret P(1+r)n as the product of P and a factor not depending on P.

Write expressions in equivalent forms to solve problems

A-SSE.3 Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.*

c. Use the properties of exponents to transform expressions for exponential functions. For example the expression 1.15t can be rewritten as $[1.151/12]\ 12t \approx 1.01212t$ to reveal the approximate equivalent monthly interest rate if the annual rate is 15%.

Create equations that describe numbers or relationships

A-CED.1 Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.*

A-CED.2 Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.*

A-CED.3 Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or non-viable options in a modeling context. For example, represent inequalities describing nutritional and cost constraints on combinations of different foods.*

A-CED.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. For example, rearrange Ohm's law V = IR to highlight resistance R.*

Integrated Mathematics I

Solve equations and inequalities in one variable

A-REI.3 Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.

Solve systems of equations

A-REI.5 Prove that, given a system of two equations in two variables, replacing one equation by the sum of that equation and a multiple of the other produces a system with the same solutions.

A-REI.6 Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.

Represent and solve equations and inequalities graphically

A-REI.10 Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line).

A-REI.11 Explain why the x-coordinates of the points where the graphs of the equations $y = f(x)$ and $y = g(x)$ intersect are the solutions of the equation $f(x) = g(x)$; find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where $f(x)$ and/or $g(x)$ are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.*

A-REI.12 Graph the solutions to a linear inequality in two variables as a half-plane (excluding the boundary in the case of a strict inequality), and graph the solution set to a system of linear inequalities in two variables as the intersection of the corresponding half-planes.

Functions

Understand the concept of a function and use function notation

F-IF.1 Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then $f(x)$ denotes the output of f corresponding to the input x. The graph of f is the graph of the equation $y = f(x)$.

F-IF.2 Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.

F-IF.3 Recognize that sequences are functions, sometimes defined recursively, whose domain is a subset of the integers. For example, the Fibonacci sequence is defined recursively by $f(0) = f(1) = 1$, $f(n+1) = f(n) + f(n-1)$ for $n \geq 1$.

Interpret functions that arise in applications in terms of the context

F-IF.4 For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.*

Integrated Mathematics I

F-IF.5 Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. For example, if the function h(n) gives the number of person-hours it takes to assemble n engines in a factory, then the positive integers would be an appropriate domain for the function.*

F-IF.6 Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.*

Analyze functions using different representations

F-IF.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.*

a. Graph linear and quadratic functions and show intercepts, maxima, and minima.

F-IF.9 Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum.

Build a function that models a relationship between two quantities

F-BF.1 Write a function that describes a relationship between two quantities.* a. Determine an explicit expression, a recursive process, or steps for calculation from a context.

F-BF.2 Write arithmetic and geometric sequences both recursively and with an explicit formula, use them to model situations, and translate between the two forms.*

Construct and compare linear, quadratic, and exponential models and solve problems

F-LE.1 Distinguish between situations that can be modeled with linear functions and with exponential functions.*

a. Prove that linear functions grow by equal differences over equal intervals and that exponential functions grow by equal factors over equal intervals.

b. Recognize situations in which one quantity changes at a constant rate per unit interval relative to another.

c. Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another.

F-LE.2 Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table).*

F-LE.3 Observe using graphs and tables that a quantity increasing exponentially eventually exceeds a quantity increasing linearly, quadratically, or (more generally) as a polynomial function.*

Interpret expressions for functions in terms of the situation they model

F-LE.5 Interpret the parameters in a linear or exponential function in terms of a context.*

Integrated Mathematics I

Geometry

Experiment with transformations in the plane

G-CO.1 Know precise definitions of angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and distance around a circular arc.

G-CO.2 Represent transformations in the plane using, e.g., transparencies and geometry software; describe transformations as functions that take points in the plane as inputs and give other points as outputs. Compare transformations that preserve distance and angle to those that do not (e.g., translation versus horizontal stretch).

G-CO.3 Given a rectangle, parallelogram, trapezoid, or regular polygon, describe the rotations and reflections that carry it onto itself.

G-CO.4 Develop definitions of rotations, reflections, and translations in terms of angles, circles, perpendicular lines, parallel lines, and line segments.

G-CO.5 Given a geometric figure and a rotation, reflection, or translation, draw the transformed figure using, e.g., graph paper, tracing paper, or geometry software. Specify a sequence of transformations that will carry a given figure onto another.

Understand congruence in terms of rigid motions

G-CO.6 Use geometric descriptions of rigid motions to transform figures and to predict the effect of a given rigid motion on a given figure; given two figures, use the definition of congruence in terms of rigid motions to decide if they are congruent.

G-CO.7 Use the definition of congruence in terms of rigid motions to show that two triangles are congruent if and only if corresponding pairs of sides and corresponding pairs of angles are congruent.

G-CO.8 Explain how the criteria for triangle congruence (ASA, SAS, and SSS) follow from the definition of congruence in terms of rigid motions.

Prove geometric theorems

G-CO.9 Prove theorems about lines and angles. Theorems include: vertical angles are congruent; when a transversal crosses parallel lines, alternate interior angles are congruent and corresponding angles are congruent; points on a perpendicular bisector of a line segment are exactly those equidistant from the segment's endpoints.

G-CO.10 Prove theorems about triangles. Theorems include: measures of interior angles of a triangle sum to 180; base angles of isosceles triangles are congruent; the segment joining midpoints of two sides of a triangle is parallel to the third side and half the length; the medians of a triangle meet at a point.

G-CO.11 Prove theorems about parallelograms. Theorems include: opposite sides are congruent, opposite angles are congruent, the diagonals of a parallelogram bisect each other, and conversely, rectangles are parallelograms with congruent diagonals.

Integrated Mathematics I

Statistics and Probability

Summarize, represent, and interpret data on a single count or measurement variable

S-ID.1 Represent data with plots on the real number line (dot plots, histograms, and box plots).*

S-ID.2 Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets.*

S-ID.3 Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers).*

Summarize, represent, and interpret data on two categorical and quantitative variables

S-ID.5 Summarize categorical data for two categories in two-way frequency tables. Interpret relative frequencies in the context of the data (including joint, marginal, and conditional relative frequencies). Recognize possible associations and trends in the data.*

S-ID.6 Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.*

a. Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear, quadratic, and exponential models.

c. Fit a linear function for a scatter plot that suggests a linear association.

Interpret linear models

S-ID.7 Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.*

S-ID.8 Compute (using technology) and interpret the correlation coefficient of a linear fit.*

S-ID.9 Distinguish between correlation and causation.*

Integrated Mathematics I

Number and Quantity

Extend the properties of exponents to rational exponents

N-RN.1 Explain how the definition of the meaning of rational exponents follows from extending the properties of integer exponents to those values, allowing for a notation for radicals in terms of rational exponents. For example, we define 51/3 to be the cube root of 5 because we want [51/3] 3 = 5(1/3) 3 to hold, so [51/3] 3 must equal 5.

N-RN.2 Rewrite expressions involving radicals and rational exponents using the properties of exponents.

Use properties of rational and irrational numbers

N-RN.3 Explain why the sum or product of two rational numbers is rational; that the sum of a rational number and an irrational number is irrational; and that the product of a nonzero rational number and an irrational number is irrational.

Reason quantitatively and use units to solve problems

N-Q.2 Define appropriate quantities for the purpose of descriptive modeling.*

Perform arithmetic operations with complex numbers

N-CN.1 Know there is a complex number i such that i 2 = −1, and every complex number has the form a + bi with a and b real.

N-CN.2 Use the relation i 2 = –1 and the commutative, associative, and distributive properties to add, subtract, and multiply complex numbers.

Use complex numbers in polynomial identities and equations

N-CN.7 Solve quadratic equations with real coefficients that have complex solutions.

Algebra

Interpret the structure of expressions

A-SSE.1 Interpret expressions that represent a quantity in terms of its context.* b. Interpret complicated expressions by viewing one or more of their parts as a single entity. For example, interpret P(1+r)n as the product of P and a factor not depending on P.

Integrated Mathematics II

A-SSE.2 Use the structure of an expression to identify ways to rewrite it. For example, see x4 – y 4 as (x2) 2 – (y2) 2, thus recognizing it as a difference of squares that can be factored as (x2 – y 2) (x2 + y2).

Write expressions in equivalent forms to solve problems

A-SSE.3 Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.*

a. Factor a quadratic expression to reveal the zeros of the function it defines.

b. Complete the square in a quadratic expression to reveal the maximum or minimum value of the function it defines.

Perform arithmetic operations on polynomials

A-APR.1 Understand that polynomials form a system analogous to the integers, namely, they are closed under the operations of addition, subtraction, and multiplication; add, subtract, and multiply polynomials.

Create equations that describe numbers or relationships

A-CED.1 Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.*

A-CED.2 Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.*

A-CED.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. For example, rearrange Ohm's law V = IR to highlight resistance R.*

Understand solving equations as a process of reasoning and explain the reasoning M

A-REI.1 Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method.

Solve equations and inequalities in one variable

A-REI.4 Solve quadratic equations in one variable.

a. Use the method of completing the square to transform any quadratic equation in x into an equation of the form $(x - p)\ 2 = q$ that has the same solutions. Derive the quadratic formula from this form.

b. Solve quadratic equations by inspection (e.g., for $x\ 2 = 49$), taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions and write them as $a \pm bi$ for real numbers a and b.

Solve systems of equations

A-REI.7 Solve a simple system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically. For example, find the points of intersection between the line $y = -3x$ and the circle $x2 + y2 = 3$.

Functions

Interpret functions that arise in applications in terms of the context M

F-IF.4 For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.*

F-IF.5 Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. For example, if the function h(n) gives the number of person-hours it takes to assemble n engines in a factory, then the positive integers would be an appropriate domain for the function.*

F-IF.6 Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.*

Analyze functions using different representations

F-IF.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.*

a. Graph linear and quadratic functions and show intercepts, maxima, and minima.

b. Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions.

e. Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude.

F-IF.8 Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function.

a. Use the process of factoring and completing the square in a quadratic function to show zeros, extreme values, and symmetry of the graph, and interpret these in terms of a context.

b. Use the properties of exponents to interpret expressions for exponential functions. For example, identify percent rate of change in functions such as $y = (1.02)t$, $y = (0.97)t$, $y = (1.01)12t$, $y = (1.2)t/10$, and classify them as representing exponential growth and decay.

F-IF.9 Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum.

Integrated Mathematics II

Build a function that models a relationship between two quantities

F-BF.1 Write a function that describes a relationship between two quantities.*

a. Determine an explicit expression, a recursive process, or steps for calculation from a context.

b. Combine standard function types using arithmetic operations. For example, build a function that models the temperature of a cooling body by adding a constant function to a decaying exponential, and relate these functions to the model.

Build new functions from existing functions

F-BF.3 Identify the effect on the graph of replacing f(x) by f(x) + k, k f(x), f(kx), and f(x + k) for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them.

Geometry

Understand similarity in terms of similarity transformations

G-SRT.1 Verify experimentally the properties of dilations given by a center and a scale factor:
a. A dilation takes a line not passing through the center of the dilation to a parallel line, and leaves a line passing through the center unchanged.
b. The dilation of a line segment is longer or shorter in the ratio given by the scale factor.
G-SRT.2 Given two figures, use the definition of similarity in terms of similarity transformations to decide if they are similar; explain using similarity transformations the meaning of similarity for triangles as the equality of all corresponding pairs of angles and the proportionality of all corresponding pairs of sides.
G-SRT.3 Use the properties of similarity transformations to establish the AA criterion for two triangles to be similar.

Prove theorems using similarity

G-SRT.4 Prove theorems about triangles. Theorems include: a line parallel to one side of a triangle divides the other two proportionally, and conversely; the Pythagorean Theorem proved using triangle similarity.
G-SRT.5 Use congruence and similarity criteria for triangles to solve problems and to prove relationships in geometric figures.

Define trigonometric ratios and solve problems involving right triangles

G-SRT.6 Understand that by similarity, side ratios in right triangles are properties of the angles in the triangle, leading to definitions of trigonometric ratios for acute angles.
G-SRT.7 Explain and use the relationship between the sine and cosine of complementary angles.

Integrated Mathematics II

G-SRT.8 Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems.*

Explain volume formulas and use them to solve problems

G-GMD.1 Give an informal argument for the formulas for the circumference of a circle, area of a circle, volume of a cylinder, pyramid, and cone. Use dissection arguments, Cavalieri's principle, and informal limit arguments.
G-GMD.3 Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems.*

Statistics and Probability*

Summarize, represent, and interpret data on two categorical and quantitative variables

S-ID.6 Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.*
a. Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear, quadratic, and exponential models.
b. Informally assess the fit of a function by plotting and analyzing residuals.

Understand independence and conditional probability and use them to interpret data

S-CP.1 Describe events as subsets of a sample space (the set of outcomes) using characteristics (or categories) of the outcomes, or as unions, intersections, or complements of other events ("or," "and," "not").*
S-CP.2 Understand that two events A and B are independent if the probability of A and B occurring together is the product of their probabilities, and use this characterization to determine if they are independent.*

S-CP.3 Understand the conditional probability of A given B as P(A and B)/P(B), and interpret independence of A and B as saying that the conditional probability of A given B is the same as the probability of A, and the conditional probability of B given A is the same as the probability of B.*
S-CP.4 Construct and interpret two-way frequency tables of data when two categories are associated with each object being classified. Use the two-way table as a sample space to decide if events are independent and to approximate conditional probabilities. For example, collect data from a random sample of students in your school on their favorite subject among math, science, and English. Estimate the probability that a randomly selected student from your school will favor science given that the student is in tenth grade. Do the same for other subjects and compare the results.*
S-CP.5 Recognize and explain the concepts of conditional probability and independence in everyday language and everyday situations. For example, compare the chance of having lung cancer if you are a smoker with the chance of being a smoker if you have lung cancer.

Integrated Mathematics II

Use the rules of probability to compute probabilities of compound events in a uniform probability model

S-CP.6 Find the conditional probability of A given B as the fraction of B's outcomes that also belong to A, and interpret the answer in terms of the model.*
S-CP.7 Apply the Addition Rule, P(A or B) = P(A) + P(B) – P(A and B), and interpret the answer in terms of the model.*

Integrated Mathematics III
Number and Quantity

Reason quantitatively and use units to solve problems

N-Q.2 Define appropriate quantities for the purpose of descriptive modeling.*

Algebra

Interpret the structure of expressions

A-SSE.2 Use the structure of an expression to identify ways to rewrite it. For example, see x4 – y 4 as (x2) 2 – (y2) 2 , thus recognizing it as a difference of squares that can be factored as (x2 – y 2)(x2 + y2).

Write expressions in equivalent forms to solve problems

A-SSE.4 Derive the formula for the sum of a finite geometric series (when the common ratio is not 1), and use the formula to solve problems. For example, calculate mortgage payments.*

Understand the relationship between zeros and factors of polynomials

A-APR.2 Know and apply the Remainder Theorem: For a polynomial p(x) and a number a, the remainder on division by x – a is p(a), so p(a) = 0 if and only if (x – a) is a factor of p(x).
A-APR.3 Identify zeros of polynomials when suitable factorizations are available, and use the zeros to construct a rough graph of the function defined by the polynomial.

Use polynomial identities to solve problems

A-APR.4 Prove polynomial identities and use them to describe numerical relationships. For example, the polynomial identity (x2 + y2) 2 = (x2 – y 2) 2 + (2xy)2 can be used to generate Pythagorean triples.

Rewrite rational expressions

A-APR.6 Rewrite simple rational expressions in different forms; write a(x)/b(x) in the form q(x) + r(x)/b(x), where a(x), b(x), q(x), and r(x) are polynomials with the degree of r(x) less than the degree of b(x), using inspection, long division, or, for the more complicated examples, a computer algebra system.

Integrated Mathematics III

Create equations that describe numbers or relationships

A-CED.1 Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.*
A-CED.2 Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.*

Understand solving equations as a process of reasoning and explain the reasoning

A-REI.1 Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method.

A-REI.2 Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise.

Represent and solve equations and inequalities graphically

A-REI.11 Explain why the x-coordinates of the points where the graphs of the equations $y = f(x)$ and $y = g(x)$ intersect are the solutions of the equation $f(x) = g(x)$; find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where $f(x)$ and/or $g(x)$ are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.*

Interpret functions that arise in applications in terms of the context

F-IF.4 For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.*

F-IF.6 Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.*

Analyze functions using different representations

F-IF.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.* c. Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior. e. Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude.

F-IF.9 Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum.

Build new functions from existing functions

F-BF.3 Identify the effect on the graph of replacing $f(x)$ by $f(x) + k$, $k\,f(x)$, $f(kx)$, and $f(x + k)$ for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them.

F-BF.4 Find inverse functions. a. Solve an equation of the form $f(x) = c$ for a simple function f that has an inverse and write an expression for the inverse. For example, $f(x) = 2x3$ or $f(x) = (x+1)/(x-1)$ for $x \neq 1$.

Construct and compare linear, quadratic, and exponential models and solve problems

F-LE.4 For exponential models, express as a logarithm the solution to $abct = d$ where a, c, and d are numbers and the base b is 2, 10, or e; evaluate the logarithm using technology.*

Extend the domain of trigonometric functions using the unit circle

F-TF.1 Understand radian measure of an angle as the length of the arc on the unit circle subtended by the angle.

F-TF.2 Explain how the unit circle in the coordinate plane enables the extension of trigonometric functions to all real numbers, interpreted as radian measures of angles traversed counterclockwise around the unit circle.

Model periodic phenomena with trigonometric functions

F-TF.5 Choose trigonometric functions to model periodic phenomena with specified amplitude, frequency, and midline.*

Prove and apply trigonometric identities

F-TF.8 Prove the Pythagorean identity sin (Θ)2 + cos (Θ)2 = 1 and use it to find sin (Θ), cos (Θ), or tan (Θ), given sin (Θ), cos (Θ), or tan (Θ) and the quadrant of the angle.

Integrated Mathematics III
Geometry

Make geometric constructions

G-CO.12 Make formal geometric constructions with a variety of tools and methods (compass and straightedge, string, reflective devices, paper folding, dynamic geometric software, etc.). Copying a segment; copying an angle; bisecting a segment; bisecting an angle; constructing perpendicular lines, including the perpendicular bisector of a line segment; and constructing a line parallel to a given line through a point not on the line.

G-CO.13 Construct an equilateral triangle, a square, and a regular hexagon inscribed in a circle.

Understand and apply theorems about circles

G-C.1 Prove that all circles are similar.

G-C.2 Identify and describe relationships among inscribed angles, radii, and chords. Include the relationship between central, inscribed, and circumscribed angles; inscribed angles on a diameter are right angles; the radius of a circle is perpendicular to the tangent where the radius intersects the circle.

G-C.3 Construct the inscribed and circumscribed circles of a triangle, and prove properties of angles for a quadrilateral inscribed in a circle.

Find arc lengths and areas of sectors of circles

G-C.5 Derive using similarity the fact that the length of the arc intercepted by an angle is proportional to the radius, and define the radian measure of the angle as the constant of proportionality; derive the formula for the area of a sector.

Translate between the geometric description and the equation for a conic section

G-GPE.1 Derive the equation of a circle of given center and radius using the Pythagorean Theorem; complete the square to find the center and radius of a circle given by an equation.

G-GPE.2 Derive the equation of a parabola given a focus and directrix.

Use coordinates to prove simple geometric theorems algebraically

G-GPE.4 Use coordinates to prove simple geometric theorems algebraically. For example, prove or disprove that a figure defined by four given points in the coordinate plane is a rectangle; prove or disprove that the point (1, $\sqrt{3}$) lies on the circle centered at the origin and containing the point (0, 2).

G-GPE.5 Prove the slope criteria for parallel and perpendicular lines and use them to solve geometric problems (e.g., find the equation of a line parallel or perpendicular to a given line that passes through a given point).

Integrated Mathematics III

G-GPE.6 Find the point on a directed line segment between two given points that partitions the segment in a given ratio.

G-GPE.7 Use coordinates to compute perimeters of polygons and areas of triangles and rectangles, e.g., using the distance formula.*

Visualize relationships between two-dimensional and three-dimensional objects

G-GMD.4 Identify the shapes of two-dimensional cross-sections of three-dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects.

Apply geometric concepts in modeling situations

G-MG.1 Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).*

G-MG.2 Apply concepts of density based on area and volume in modeling situations (e.g., persons per square mile, BTUs per cubic foot).*

G-MG.3 Apply geometric methods to solve design problems (e.g., designing an object or structure to satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios).*

Statistics and Probability*

Summarize, represent, and interpret data on a single count or measurement variable S

S-ID.4 Use the mean and standard deviation of a data set to fit it to a normal distribution and to estimate population percentages. Recognize that there are data sets for which such a procedure is not appropriate. Use calculators, spreadsheets, and tables to estimate areas under the normal curve.*

Summarize, represent, and interpret data on two categorical and quantitative variables

S-ID.6 Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.*

a. Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear, quadratic, and exponential models.

b. Informally assess the fit of a function by plotting and analyzing residuals.

Understand and evaluate random processes underlying statistical experiments

S-IC.1 Understand statistics as a process for making inferences about population parameters based on a random sample from that population.

Integrated Mathematics III

S-IC.2 Decide if a specified model is consistent with results from a given data-generating process, e.g., using simulation. For example, a model says a spinning coin falls heads up with probability 0.5. Would a result of 5 tails in a row cause you to question the model?*

Make inferences and justify conclusions from sample surveys, experiments, and observational studies

S-IC.3 Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each.*

S-IC.4 Use data from a sample survey to estimate a population mean or proportion; develop a margin of error through the use of simulation models for random sampling.*

S-IC.5 Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant.*

S-IC.6 Evaluate reports based on data.*

Advanced Mathematics Plus

Number and Quantity

Perform arithmetic operations with complex numbers

N-CN.3 Find the conjugate of a complex number; use conjugates to find moduli and quotients of complex numbers.

Represent complex numbers and their operations on the complex plane

N-CN.4 Represent complex numbers on the complex plane in rectangular and polar form (including real and imaginary numbers), and explain why the rectangular and polar forms of a given complex number represent the same number.

N-CN.5 Represent addition, subtraction, multiplication, and conjugation of complex numbers geometrically on the complex plane; use properties of this representation for computation. For example, $(-1 + \sqrt{3}\ i)3 = 8$ because $(-1 + \sqrt{3}\ i)$ has modulus 2 and argument 120°.

N-CN.6 Calculate the distance between numbers in the complex plane as the modulus of the difference, and the midpoint of a segment as the average of the numbers at its endpoints.

Use complex numbers in polynomial identities and equations

N-CN.8 Extend polynomial identities to the complex numbers. For example, rewrite x2 + 4 as (x + 2i)(x – 2i).

N-CN.9 Know the Fundamental Theorem of Algebra; show that it is true for quadratic polynomials

Represent and model with vector quantities

N-VM.1 Recognize vector quantities as having both magnitude and direction. Represent vector quantities by directed line segments, and use appropriate symbols for vectors and their magnitudes (e.g., v, |v|, ||v||, v).
N-VM.2 Find the components of a vector by subtracting the coordinates of an initial point from the coordinates of a terminal point.
N-VM.3 Solve problems involving velocity and other quantities that can be represented by vectors.

Advanced Mathematics Plus

Perform operations on vectors

N-VM.4 Add and subtract vectors.
a. Add vectors end-to-end, component-wise, and by the parallelogram rule. Understand that the magnitude of a sum of two vectors is typically not the sum of the magnitudes.
b. Given two vectors in magnitude and direction form, determine the magnitude and direction of their sum.
c. Understand vector subtraction v – w as v + (–w), where –w is the additive inverse of w, with the same magnitude as w and pointing in the opposite direction. Represent vector subtraction graphically by connecting the tips in the appropriate order, and perform vector subtraction component-wise.
N-VM.5 Multiply a vector by a scalar.
a. Represent scalar multiplication graphically by scaling vectors and possibly reversing their direction; perform scalar multiplication component-wise, e.g., as c(vx, vy) = (cvx, cvy).
b. Compute the magnitude of a scalar multiple cv using ||cv|| = |c|v. Compute the direction of cv knowing that when |c|v 0, the direction of cv is either along v (for c > 0) or against v (for c < 0).

Perform operations on matrices and use matrices in applications

N-VM.6 Use matrices to represent and manipulate data, e.g., to represent payoffs or incidence relationships in a network.
N-VM.7 Multiply matrices by scalars to produce new matrices, e.g., as when all of the payoffs in a game are doubled.
N-VM.8 Add, subtract, and multiply matrices of appropriate dimensions.
N-VM.9 Understand that, unlike multiplication of numbers, matrix multiplication for square matrices is not a commutative operation, but still satisfies the associative and distributive properties.
N-VM.10 Understand that the zero and identity matrices play a role in matrix addition and multiplication similar to the role of 0 and 1 in the real numbers. The determinant of a square matrix is nonzero if and only if the matrix has a multiplicative inverse.
N-VM.11 Multiply a vector (regarded as a matrix with one column) by a matrix of suitable dimensions to produce another vector. Work with matrices as transformations of vectors.
N-VM.12 Work with 2 × 2 matrices as transformations of the plane, and interpret the absolute value of the determinant in terms of area.

Algebra

Use polynomial identities to solve problems

A-APR.5 Know and apply the Binomial Theorem for the expansion of (x + y) n in powers of x and y for a positive integer n, where x and y are any numbers, with coefficients determined for example by Pascal's Triangle.

Advanced Mathematics Plus

Rewrite rational expressions

A-APR.7 Understand that rational expressions form a system analogous to the rational numbers, closed under addition, subtraction, multiplication, and division by a nonzero rational expression; add, subtract, multiply, and divide rational expressions.

Solve systems of equations

A-REI.8 Represent a system of linear equations as a single matrix equation in a vector variable.
A-REI.9 Find the inverse of a matrix if it exists and use it to solve systems of linear equations (using technology for matrices of dimension 3 × 3 or greater).

Functions

Analyze functions using different representations

F-IF.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.*

d. Graph rational functions, identifying zeros and asymptotes when suitable factorizations are available, and showing end behavior.

Build a function that models a relationship between two quantities

F-BF.1 Write a function that describes a relationship between two quantities. *

c. Compose functions. For example, if T(y) is the temperature in the atmosphere as a function of height, and h(t) is the height of a weather balloon as a function of time, then T(h(t)) is the temperature at the location of the weather balloon as a function of time.

Build new functions from existing functions

F-BF.4 Find inverse functions.

b. Verify by composition that one function is the inverse of another.

c. Read values of an inverse function from a graph or a table, given that the function has an inverse.

d. Produce an invertible function from a non-invertible function by restricting the domain.

F-BF.5 Understand the inverse relationship between exponents and logarithms and use this relationship to solve problems involving logarithms and exponents.

Advanced Mathematics Plus

Extend the domain of trigonometric functions using the unit circle

F-TF.3 Use special triangles to determine geometrically the values of sine, cosine, tangent for $\pi/3$, $\pi/4$ and $\pi/6$, and use the unit circle to express the values of sine, cosine, and tangent for $\pi-x$, $\pi+x$, and $2\pi-x$ in terms of their values for x, where x is any real number.

F-TF.4 Use the unit circle to explain symmetry (odd and even) and periodicity of trigonometric functions.

Model periodic phenomena with trigonometric functions

F-TF.6 Understand that restricting a trigonometric function to a domain on which it is always increasing or always decreasing allows its inverse to be constructed.

F-TF.7 Use inverse functions to solve trigonometric equations that arise in modeling contexts; evaluate the solutions using technology, and interpret them in terms of the context. *

Prove and apply trigonometric identities

F-TF.9 Prove the addition and subtraction formulas for sine, cosine, and tangent and use them to solve problems.

Geometry

Apply trigonometry to general triangles

G-SRT.9 Derive the formula $A = \frac{1}{2}$ ab sin(C) for the area of a triangle by drawing an auxiliary line from a vertex perpendicular to the opposite side.

G-SRT.10 Prove the Laws of Sines and Cosines and use them to solve problems.

G-SRT.11 Understand and apply the Law of Sines and the Law of Cosines to find unknown measurements in right and non-right triangles (e.g., surveying problems, resultant forces).

Understand and apply theorems about circles

G-C.4 Construct a tangent line from a point outside a given circle to the circle.

Translate between the geometric description and the equation for a conic section

Advanced Mathematics Plus

G-GPE.3 Derive the equations of ellipses and hyperbolas given the foci, using the fact that the sum or difference of distances from the foci is constant.

Explain volume formulas and use them to solve problems

G-GMD.2 Give an informal argument using Cavalieri's principle for the formulas for the volume of a sphere and other solid figures.

Statistics and Probability*

Use the rules of probability to compute probabilities of compound events in a uniform probability model

S-CP.8 Apply the general Multiplication Rule in a uniform probability model, P(A and B) = P(A)P(B|A) = P(B)P(A|B), and interpret the answer in terms of the model.*

S-CP.9 Use permutations and combinations to compute probabilities of compound events and solve problems.*

Calculate expected values and use them to solve problems

S-MD.1 Define a random variable for a quantity of interest by assigning a numerical value to each event in a sample space; graph the corresponding probability distribution using the same graphical displays as for data distributions.*

S-MD.2 Calculate the expected value of a random variable; interpret it as the mean of the probability distribution.*

S-MD.3 Develop a probability distribution for a random variable defined for a sample space in which theoretical probabilities can be calculated; find the expected value. For example, find the theoretical probability distribution for the number of correct answers obtained by guessing on all five questions of a multiple-choice test where each question has four choices, and find the expected grade under various grading schemes.*

S-MD.4 Develop a probability distribution for a random variable defined for a sample space in which probabilities are assigned empirically; find the expected value. For example, find a current data distribution on the number of TV sets per household in the United States, and calculate the expected number of sets per household. How many TV sets would you expect to find in 100 randomly selected households?*

Advanced Mathematics Plus

Use probability to evaluate outcomes of decisions

S-MD.5 Weigh the possible outcomes of a decision by assigning probabilities to payoff values and finding expected values. *

a. Find the expected payoff for a game of chance. For example, find the expected winnings from a state lottery ticket or a game at a fast-food restaurant.

b. Evaluate and compare strategies on the basis of expected values. For example, compare a high-deductible versus a low-deductible automobile insurance policy using various, but reasonable, chances of having a minor or a major accident.*

S-MD.6 Use probabilities to make fair decisions (e.g., drawing by lots, using a random number generator).*

S-MD.7 Analyze decisions and strategies using probability concepts (e.g., product testing, medical testing, pulling a hockey goalie at the end of a game).*