Newport-Mesa Unified School District
Office of Secondary Curriculum and Instruction
Middle School Course of Study

Course Title	*Science Technology Engineering Mathamatics -STEM (MS)*	**Course Code**	*[Office use only]*

Content Area:	*Interdisciplinary*	Grade Range:	*7-8*	Board Adoption Date:	
Transcript Title:	*STEM Explorations*	What site wrote the course:		*Costa Mesa Middle School*	
Recommend Skills:	*None*			Length of Course:	*1 Year*
What Textbook will be used:		Credential Req:	Science		

COURSE DESCRIPTION *(catalog summary)*:

STEM (Science, Technology, Engineering, and Mathematics) Explorations students will apply principles of science, integrated with math, and the engineering design process to develop projects related to various disciplines in engineering. In this year-long course, students will complete a series of engineering design challenges (hands-on projects) culminating with competition-ready devices such as but not limited to: popsicle stick bridge, mechanical prosthetic arm, mousetrap-powered car, and balsawood glider. These projects promote critical thinking, communication, collaboration, creativity and provide a foundation for data collection, analysis, reflection, presentations and technical writing skills.

Unit 1 – The Engineering Design Process (2 weeks)
In this unit, students will be introduced to the engineering design process that will be used for the remainder of the year as a tool to solve multiple engineering design problems. Students will gain insight by watching introductory engineering videos that describe the engineering design process such as those found on Crash Course Kids and SciShow Kids.

Unit 2 – Popsicle Stick Bridge - Civil Engineering (6-8 weeks)
In this unit, students will focus on civil engineering projects that will lead them to a culminating project to build a popsicle stick bridge to test for strength-to-weight ratio. Students will gain knowledge of shapes civil engineers use to apply a strong foundation and support for structures. Varying truss shapes will be used to build several structures to investigate the structural integrity. Students will calculate the surface area of their bridge, weight of their bridge, and the strength-to-weight ratio.

Unit 3 – Mechanical Prosthetic Arm - Biomedical Engineering (6-8 weeks)
In this unit, students will focus on biomedical engineering to research prosthetic devices through selected readings and recommended online websites. Combining biomedical engineering, biotechnology, and kinematics, this unit culminates with the design and construction of a working prosthetic arm. Utilizing principles of mechanical engineering, students need to activate the fingers of the hand to grasp and relocate various specified objects. To design and construct the arm and hand students will conduct online research to investigate the following: types of motion, magnitude of motion, direction of motion, location of motion – kinematics. Included in the development of the project are scaled plans and renderings. The notebook must contain examples of math and science concepts used in the design of the arm such as how each material used corresponded to a bone or muscle in the arm.

Unit 4 – Balsawood Glider - Aeronautical/Aerospace Engineering (6-8 weeks)

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In this unit, student will be applying the principles of flight and aircraft design applied to the construction of a balsawood glider. Objectives of this unit include: analysis of design and construction in relation to the flight mission; application of principles of the engineering design cycle to aircraft design and construction; problem solving related to flight, lift and drag; problem solving related to balance and torque. Students will be required to calculate the surface area of two or three-dimensional objects composed of different geometric shapes.

Unit 5 – Mousetrap-Powered Car - Mechanical Engineering (6-8 weeks)
In this unit, students will focus on mechanical engineering by exploring how do things move and what keeps objects in motion. Selected readings and guided research will help students to develop kinematic concepts of motion and apply this knowledge to the design challenge. The design challenge in unit one is to build a car propelled by the energy released in the snap of a mousetrap to power the car across five meters. Through this investigation students apply their understanding of kinematics to analyze motion by making measurements and calculations as well as exploring the need for transportation.

Note: Projects and units may change as further curriculum is refined and developed

GOALS *(expected performance outcomes for students)***:**
Utilizing the engineering design process, students will be guided through project based learning modules to gain insight into engineering as well as the skills to systematically approach real-world problems. Students use hands-on activities and project-based learning to retain math and science concepts. Each unit introduces students to the real-world application of the skills and principles and highlights how they relate to possible careers in STEM fields. All units utilize the engineering design process and require students to keep an “Engineering Design Notebook” to document their thought processes, test data, as well provide insight into the design, test, and redesign process.

CALIFORNIA CONTENT STANDARDS *(how the course aligns with California and/or national curriculum standards)***:**
Common Core State Standards for English Language Arts
Common Core State Standards for Mathematical Practice (6-8)
Next Generation Science Standards Middle School

Common Core State Standards for English Language Arts

Reading
1. Read closely to determine what the text says explicitly and to make logical inferences from it; cite specific textual evidence when writing or speaking to support conclusions drawn from the text. (AS.R.1)
2. Determine central ideas or themes of a text and analyze their development; summarize the key supporting details and ideas. (AS.R.2)
7. Integrate and evaluate content presented in diverse formats and media, including visually and quantitatively, as well as in words. (AS.R.7)
10. Read and comprehend complex literary and informational texts independently and proficiently. (AS.R.10)

Text Types and Purposes
4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. (AS.W.4)
6. Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others. (AS.W.6)

8. Gather relevant information from multiple print and digital sources, assess the credibility and accuracy of each source, and integrate the information while avoiding plagiarism. (AS.W.8)
10. Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes, and audiences. (AS.W.10)

Comprehension and Collaboration
1. Prepare for and participate effectively in a range of conversations and collaborations with diverse partners, building on others' ideas and expressing their own clearly and persuasively. (AS.SL.1)
2. Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally. (AS.SL.2)
4. Present information, findings, and supporting evidence such that listeners can follow the line of reasoning and the organization, development, and style are appropriate to task, purpose, and audience. (AS.SL.4)
5. Make strategic use of digital media and visual displays of data to express information and enhance understanding of presentations. (AS.SL.5)

Conventions of Standard English
1. Demonstrate command of the conventions of standard English grammar and usage when writing or speaking. (AS.L.1)
2. Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing. (AS.L.2)
6. Acquire and use accurately a range of general academic and domain-specific words and phrases sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression. (AS.L.6)

Common Core State Standards for Mathematical Practice (6-8)

Grade 6
Ratios and Proportional Relationships
Understand ratio concepts and use ratio reasoning to solve problems.
3. Use ratio and rate reasoning to solve real-world and mathematical problems, e.g., by reasoning about tables of equivalent ratios, tape diagrams, double number line diagrams, or equations. (6.RP.A.3)
3.b. Solve unit rate problems including those involving unit pricing and constant speed. (6.RP.A.3b)
3.d. Use ratio reasoning to convert measurement units; manipulate and transform units appropriately when multiplying or dividing quantities. (6.RP.A.3d)

The Number System
Compute fluently with multi-digit numbers and find common factors and multiples.
2. Fluently divide multi-digit numbers using the standard algorithm. (6.NS.B.2)
3. Fluently add, subtract, multiply, and divide multi-digit decimals using the standard algorithm for each operation. (6.NS.B.3)
Apply and extend previous understandings of numbers to the system of rational numbers.
6. Understand a rational number as a point on the number line. Extend number line diagrams and coordinate axes familiar from previous grades to represent points on the line and in the plane with negative number coordinates. (6.NS.C.6)

6.c. Find and position integers and other rational numbers on a horizontal or vertical number line diagram; find and position pairs of integers and other rational numbers on a coordinate plane. (6.NS.C.6c)

Expressions and Equations
Apply and extend previous understandings of arithmetic to algebraic expressions.
2. Write, read, and evaluate expressions in which letters stand for numbers. (6.EE.A.2)
2.a. Write expressions that record operations with numbers and with letters standing for numbers. For example, express the calculation "Subtract y from 5" as 5 – y. (6.EE.A.2a)
Reason about and solve one-variable equations and inequalities.
5. Understand solving an equation or inequality as a process of answering a question: which values from a specified set, if any, make the equation or inequality true? Use substitution to determine whether a given number in a specified set makes an equation or inequality true. (6.EE.B.5)
6. Use variables to represent numbers and write expressions when solving a real-world or mathematical problem; understand that a variable can represent an unknown number, or, depending on the purpose at hand, any number in a specified set. (6.EE.B.6)

Geometry
Solve real-world and mathematical problems involving area, surface area, and volume.
1. Find the area of right triangles, other triangles, special quadrilaterals, and polygons by composing into rectangles or decomposing into triangles and other shapes; apply these techniques in the context of solving real-world and mathematical problems. (6.G.A.1)
2. Find the volume of a right rectangular prism with fractional edge lengths by packing it with unit cubes of the appropriate unit fraction edge lengths, and show that the volume is the same as would be found by multiplying the edge lengths of the prism. Apply the formulas V = l w h and V = b h to find volumes of right rectangular prisms with fractional edge lengths in the context of solving real-world and mathematical problems. (6.G.A.2)
3. Draw polygons in the coordinate plane given coordinates for the vertices; use coordinates to find the length of a side joining points with the same first coordinate or the same second coordinate. Apply these techniques in the context of solving real-world and mathematical problems. (6.G.A.3)
4. Represent three-dimensional figures using nets made up of rectangles and triangles, and use the nets to find the surface area of these figures. Apply these techniques in the context of solving real-world and mathematical problems. (6.G.A.4)

Grade 7
Ratios and Proportional Relationships
Analyze proportional relationships and use them to solve real-world and mathematical problems.
1. Compute unit rates associated with ratios of fractions, including ratios of lengths, areas and other quantities measured in like or different units. For example, if a person walks 1/2 mile in each 1/4 hour, compute the unit rate as the complex fraction 1/2/1/4 miles per hour, equivalently 2 miles per hour. (7.RP.A.1)

The Number System
Apply and extend previous understandings of operations with fractions to add, subtract, multiply, and divide rational numbers.
1. Apply and extend previous understandings of addition and subtraction to add and subtract rational numbers; represent addition and subtraction on a horizontal or vertical number line diagram. (7.NS.A.1)

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Expressions and Equations
Solve real-life and mathematical problems using numerical and algebraic expressions and equations.
4. Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities. (7.EE.B.4)
4.a. Solve word problems leading to equations of the form px + q = r and p(x + q) = r, where p, q, and r are specific rationalnumbers. Solve equations of these forms fluently. Compare an algebraic solution to an arithmetic solution, identifying the sequence of the operations used in each approach. For example, the perimeter of a rectangle is 54 cm. Its length is 6 cm. What is its width? (7.EE.B.4a)

Geometry
Draw, construct, and describe geometrical figures and describe the relationships between them.
1. Solve problems involving scale drawings of geometric figures, including computing actual lengths and areas from a scale drawing and reproducing a scale drawing at a different scale. (7.G.A.1)
2. Draw (freehand, with ruler and protractor, and with technology) geometric shapes with given conditions. Focus on constructing triangles from three measures of angles or sides, noticing when the conditions determine a unique triangle, more than one triangle, or no triangle. (7.G.A.2)
3. Describe the two-dimensional figures that result from slicing three-dimensional figures, as in plane sections of right rectangular prisms and right rectangular pyramids. (7.G.A.3)
Solve real-life and mathematical problems involving angle measure, area, surface area, and volume.
4. Know the formulas for the area and circumference of a circle and use them to solve problems; give an informal derivation of the relationship between the circumference and area of a circle. (7.G.B.4)
6. Solve real-world and mathematical problems involving area, volume and surface area of two- and three-dimensional objects composed of triangles, quadrilaterals, polygons, cubes, and right prisms. (7.G.B.6)

Grade 8
Geometry
Understand congruence and similarity using physical models, transparencies, or geometry software.
1. Verify experimentally the properties of rotations, reflections, and translations: (8.G.A.1)
1.a. Lines are taken to lines, and line segments to line segments of the same length. (8.G.A.1a)
1.c. Parallel lines are taken to parallel lines. (8.G.A.1c)
1.b. Angles are taken to angles of the same measure. (8.G.A.1b)
2. Understand that a two-dimensional figure is congruent to another if the second can be obtained from the first by a sequence of rotations, reflections, and translations; given two congruent figures, describe a sequence that exhibits the congruence between them. (8.G.A.2)
6. Explain a proof of the Pythagorean Theorem and its converse. (8.G.B.6)
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.B.7)
8. Apply the Pythagorean Theorem to find the distance between two points in a coordinate system. (8.G.B.8)

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Next Generation Science Standards Middle School

Motion and Stability: Forces and Interactions
1. Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects. (MS.PS2.1)
2. Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object. (MS.PS2.2)

Energy
1. Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object. (MS.PS3.1)
2. Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system. (MS.PS3.2)

Engineering Design
1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions. (MS.ETS.1.1)
2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem. (MS.ETS.1.2)
3. Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success. (MS.ETS.1.3)
4. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved. (MS.ETS.1.4)

EVALUATION *(how students will be assessed and graded)***:**
Students will keep an engineering design notebook with proper sections which include: introduction to project, one-half page dated entries for each day's work that answers what they have planned, built, and still need to accomplish, full page detailed sketches with measurements and scaled proportions showing the progression on their work, and applied mathematics. Students will also be assessed on their project completion and device performance based on the rules and rubrics provided for each project. Competitions will be held to determine if projects meet criteria of rules and to assess device performance for possible redesign.

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Unit 1	**Length of Unit … (Days / weeks / class sessions) … 2 weeks**			
	Key Vocabulary	**Standards (referenced)**	**Model Tasks**	**Tools / Texts**
The Engineering Design Process	Extensive – please refer to individual project guidelines	See course description above for Common Core State Standards for English Language Arts, Common Core State Standards for Mathematical Practice (6-8), and Next Generation Science Standards Middle School	Balance Challenge Bowling challenge Pipe Cleaner Tower Challenge Notecard Base Challenge	Project guidelines Engineering Notebook Device supplies Engineering Design Process PowerPoint Presentation Online videos
Differentiation	**Support -- for students who are struggling with the content**	Content: Project guidelines for mini project challenges Process: Re-teaching, balanced group configurations, differentiated instruction, teacher's extra assistance. Product: Modified Engineering Design Notebook and Device Performance		
	Extension – for high achieving students.	Content: Project guidelines for mini projects Process: Challenge students to test and redesign more frequently Product: Engineering Design Notebook and Winning Device Performance		
Evaluation	***Formative Assessments*** *(ongoing & mid-lesson):* Daily checks of engineering design notebook as well as checking for understanding by asking students questions about their project.			

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	Summative Assessments (unit final evaluation): Complete check of engineering notebook which includes: Introduction, daily entries, detailed sketches, and applied mathematics. Device performance will be assessed through competition as well as meeting design rules and criteria.

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Unit 2	**Length of Unit … (Days / weeks / class sessions) … 6-8 weeks**			
	Key Vocabulary	**Standards (referenced)**	**Model Tasks**	**Tools / Texts**
Unit 2 – Popsicle Stick Bridge - Civil Engineering	Extensive – please refer to individual project guidelines	See course description above for Common Core State Standards for English Language Arts, Common Core State Standards for Mathematical Practice (6-8), and Next Generation Science Standards Middle School	Straw Tower Challenge Straw Bridge Challenge Popsicle Stick Bridge – Strength-to-Weight Ratio Competition	Project guidelines Engineering Notebook Device supplies Bridge PowerPoint Presentation Online videos
Differentiation	**Support -- for students who are struggling with the content**	Content: Project guidelines for mini project challenges and culminating project competitions Process: Re-teaching, balanced group configurations, differentiated instruction, teacher's extra assistance. Product: Modified Engineering Design Notebook and Device Performance		
	Extension – for high achieving students.	Content: Project guidelines for mini projects Process: Challenge students to test and redesign more frequently Product: Engineering Design Notebook and Winning Device Performance		
Evaluation	***Formative Assessments*** *(ongoing & mid-lesson):* Daily checks of engineering design notebook as well as checking for understanding by asking students questions about their project.			

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	Summative Assessments *(unit final evaluation):* Complete check of engineering notebook which includes: Introduction, daily entries, detailed sketches, and applied mathematics. Device performance will be assessed through competition as well as meeting design rules and criteria.

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Unit 3	**Length of Unit … (Days / weeks / class sessions) … 6-8 weeks**			
	Key Vocabulary	**Standards (referenced)**	**Model Tasks**	**Tools / Texts**
Unit 3 – Mechanical Prosthetic Arm - Biomedical Engineering	Extensive – please refer to individual project guidelines	See course description above for Common Core State Standards for English Language Arts, Common Core State Standards for Mathematical Practice (6-8), and Next Generation Science Standards Middle School	Intro to Prosthetic Arm – Object Transfer Challenge Prosthetic Hand Dexterity Challenge Mechanical Prosthetic Arm – Accuracy Competition	Project guidelines Engineering Notebook Device supplies Prosthetic Arm PowerPoint Presentation Online videos
Differentiation	**Support -- for students who are struggling with the content**	Content: Project guidelines for mini project challenges and culminating project competitions Process: Re-teaching, balanced group configurations, differentiated instruction, teacher's extra assistance. Product: Modified Engineering Design Notebook and Device Performance		
	Extension – for high achieving students.	Content: Project guidelines for mini projects Process: Challenge students to test and redesign more frequently Product: Engineering Design Notebook and Winning Device Performance		
Evaluation	***Formative Assessments*** *(ongoing & mid-lesson):* Daily checks of engineering design notebook as well as checking for understanding by asking students questions about their project.			

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	Summative Assessments *(unit final evaluation):* Complete check of engineering notebook which includes: Introduction, daily entries, detailed sketches, and applied mathematics. Device performance will be assessed through competition as well as meeting design rules and criteria.

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Unit 4	**Length of Unit … (Days / weeks / class sessions) … 6-8 weeks**			
	Key Vocabulary	**Standards (referenced)**	**Model Tasks**	**Tools / Texts**
Unit 4 – Balsawood Glider - Aeronautical/Aerospace Engineering	Extensive – please refer to individual project guidelines	See course description above for Common Core State Standards for English Language Arts, Common Core State Standards for Mathematical Practice (6-8), and Next Generation Science Standards Middle School	Foam Glider Challenge Cardboard Glider Challenge Balsawood Glider – Time in the Air Competition	Project guidelines Engineering Notebook Device supplies Glider PowerPoint Presentation Online videos
Differentiation	**Support -- for students who are struggling with the content**	Content: Project guidelines for mini project challenges and culminating project competitions Process: Re-teaching, balanced group configurations, differentiated instruction, teacher's extra assistance. Product: Modified Engineering Design Notebook and Device Performance		
	Extension – for high achieving students.	Content: Project guidelines for mini projects Process: Challenge students to test and redesign more frequently Product: Engineering Design Notebook and Winning Device Performance		
Evaluation	***Formative Assessments*** *(ongoing & mid-lesson):* Daily checks of engineering design notebook as well as checking for understanding by asking students questions about their project.			

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	Summative Assessments *(unit final evaluation):* Complete check of engineering notebook which includes: Introduction, daily entries, detailed sketches, and applied mathematics. Device performance will be assessed through competition as well as meeting design rules and criteria.

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Unit 5	**Length of Unit … (Days / weeks / class sessions) … 6-8 weeks**			
	Key Vocabulary	**Standards (referenced)**	**Model Tasks**	**Tools / Texts**
Unit 5 – Mousetrap-Powered Car - Mechanical Engineering	Extensive – please refer to individual project guidelines	See course description above for Common Core State Standards for English Language Arts, Common Core State Standards for Mathematical Practice (6-8), and Next Generation Science Standards Middle School	Passenger Vehicle Challenge Air Powered Vehicle Challenge Mousetrap Powered Car - Speed Competition	Project guidelines Engineering Notebook Device supplies Mousetrap Car PowerPoint Presentation Online videos
Differentiation	**Support -- for students who are struggling with the content**	Content: Project guidelines for mini project challenges and culminating project competitions Process: Re-teaching, balanced group configurations, differentiated instruction, teacher's extra assistance. Product: Modified Engineering Design Notebook and Device Performance		
	Extension – for high achieving students.	Content: Project guidelines for mini projects Process: Challenge students to test and redesign more frequently Product: Engineering Design Notebook and Winning Device Performance		
Evaluation	***Formative Assessments*** *(ongoing & mid-lesson):* Daily checks of engineering design notebook as well as checking for understanding by asking students questions about their project.			

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	Summative Assessments *(unit final evaluation):* Complete check of engineering notebook which includes: Introduction, daily entries, detailed sketches, and applied mathematics. Device performance will be assessed through competition as well as meeting design rules and criteria.

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Unit 6	**Length of Unit … (Days / weeks / class sessions) … 2 weeks**			
	Key Vocabulary	**Standards (referenced)**	**Model Tasks**	**Tools / Texts**
Differentiation	**Support -- for students who are struggling with the content**	Content: Process: Product:		
	Extension – for high achieving students.	Content: Process: Product:		
Evaluation	***Formative Assessments*** *(ongoing & mid-lesson):*			
	Summative Assessments *(unit final evaluation):*			

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Unit 7	**Length of Unit … (Days / weeks / class sessions) … 2 weeks**			
	Key Vocabulary	**Standards (referenced)**	**Model Tasks**	**Tools / Texts**
Differentiation	**Support -- for students who are struggling with the content**	Content: Process: Product:		
	Extension – for high achieving students.	Content: Process: Product:		
Evaluation	***Formative Assessments*** *(ongoing & mid-lesson):*			
	Summative Assessments *(unit final evaluation):*			