Secaucus Board of Education

Applied Engineering

Course Codes: 3411 & 3415

Mathematics Department

Born on January 2017

Aligned to the NJSLS for Mathematics (2016), Technology (2014), & 21st Century Life and Careers (2014)

Adopted by the Secaucus Board of Education on:January 19, 2017

District Equity Statement

The Board of Education directs that all students enrolled in the schools of this district shall be afforded equal educational opportunities in strict accordance with the law. No students shall be denied access to or benefit from any educational program or activity or from a co-curricular or athletic activity on the basis of the student's race, color, creed, religion, national origin, ancestry, age, marital status, affectional or sexual orientation, gender, gender identity or expression, socioeconomic status, or disability. The Board directs the Superintendent to allocate faculty, administrators, support staff members, curriculum materials, and instructional equipment supplies among and between the schools and classes of this district in a manner that ensures equivalency of educational opportunity throughout this district. The school district's curricula in the following areas will eliminate discrimination, promote mutual acceptance and respect among students, and enable students to interact effectively with others, regardless of race, color, creed, religion, national origin, ancestry, age, marital status, affectional or sexual orientation, gender, gender identity or expression, socioeconomic status, or disability:

1. School climate/learning environment
2. Courses of study, including Physical Education
3. Instructional materials and strategies
4. Library materials
5. Software and audio-visual materials
6. Guidance and counseling
7. Extra-curricular programs and activities
8. Testing and other assessments.

Excerpt from Secaucus Board of Education, Policy 5750, Edited September 2016.

Course Description

The objective of the Applied Engineering course is to equip the students with the basic understanding of force vectors and their operations, force equilibrium, stresses and strains of a body when the body is subjected to external loads. The subjects covered in this course provide essential technical basis for the analysis and design of civil structures. This course covers the basic topics of mechanics of materials. The principal topics are force vectors, equilibrium of rigid body, stress and strain, mechanical properties of materials, analysis and design of structural members subjected to tension, compression, torsion, bending and shear, and the transformation of stress (strain) components.

Potential Course Modifications (ELLs, Special Education, Gifted and Talented)

The course instructor will determine, with the assistance of guidance counselors, teacher assistant/aides, and/or special education teachers, what modifications will be made for his/her students. Such examples of modifications can include, but not be limited to:

- Extended time as needed
- Modification of tests and quizzes
- Preferential seating
- Alternative/Formative assessment (projects)
- Effective teacher questioning (ranging from simple recall to higher order critical thinking questions)
- Supplemental materials
- Cooperative learning
- Teacher tutoring
- Peer tutoring
- Differentiated Instruction

Unit 1:	Properties of Forces and Force Systems	
Timing:	3 weeks	
Standards:	*NJSLS Technology* 8.2.12.A.1, 8.2.12.B.1, 8.2.12.B.2, 8.2.12.E.1, 8.2.12.F.2, 8.2.8.G.1, 8.2.12.G.2 *NJSLS Mathematics* Standards for MP 1-8 *NJSLS 21st Century Life and Careers:* CRP1, CRP2, CRP4, CRP8, CRP11, CRP12	
Essential Questions:	**Objectives:**	**Activities, Investigation, and Student Experiences:**
● How Vectors are added? ● How Forces are added algebraically and graphically? ● What does Moment of force represent? *Enduring Understandings* ● Forces can be represented by vectors ● Vectors operations can be used to find the sum of the forces ● Direction of the resultant force is important in equivalent force systems ● Understand the use of	Students will be able to: ● Find component of Force ● Add and find direction of vectors ● Write equation for the moment of a force about a point ● Use equivalent force Systems	● Interactive Whiteboard Presentations ● Cooperative Group Investigations and Hands-on Labs ● Demonstrations ● Partner collaboration or individual work (depending on the topic and assignment.) ● Solving Real World Problems ● Students will show how to add forces analytically and graphically ○ http://himech.files.wordpress.com/2011/05/static-jlm-6th-ch2.pdf

Varignon's Theorem		○ http://emweb.unl.edu/negahban/em223/note6/note6.htm ○ http://pioneer.netserv.chula.ac.th/~mkuntine/42-111/files/ch1.pdf
Assessments:	**Materials:**	**Resources:**
• Performance based tasks • Technology based presentation • Observations, portfolios • Homework • Quizzes on each concepts • Unit test • Project-based learning	• Interactive Whiteboard • TI-84-89+ Graphing Calculator • TI SmartView Software • Apparatus for Statics Experiments • Beam Apparatus • Experimental Set Deflection of Trusses • Experimental Set Virtual work • Tensile testing	• Mechanics of Materials Willey 2007(Ansel C. ugural) • Mechanics of Materials 7th edition Prentice Hall (R.C. Hibber) • Statics and Mechanics of Materials McGraw-Hill (Schaum's Outlines) • YouTube presentations - Vectors, forces, moments • http://www.youtube.com/watch?v=0D8OraW_R6I • http://www.youtube.com/watch?v=CPiQ3yB4p64&feature=related • http://www.youtube.com/watch?v=6HRXt8cASRU&feature=related

Unit 2: Equilibrium of Rigid Bodies	Represent free body diagram, and solve problems of Inertia
Timing:	4 weeks

Standards:	*NJSLS Technology* 8.2.12.A.1, 8.2.12.B.1, 8.2.12.B.2, 8.2.12.E.1, 8.2.12.F.2, 8.2.8.G.2, 8.2.12.G.1 *NJSLS Mathematics* Standards for MP 1-8 *NJSLS 21st Century Life and Careers:* CRP1, CRP2, CRP4, CRP8, CRP11, CRP12	
Essential Questions:	**Objectives:**	**Activities, Investigation, and Student Experiences:**
● How to draw free body diagram? ● How to differentiate supports? ● What are the equilibrium equations? ● How to find the internal forces in the bars? ● What are centroids and moments of Inertia of sections? *Enduring Understandings* ● Free body diagram is important in equilibrium ● Support designations to find reactions ● Different ways to solve Trusses ● Moment of Inertia is the second moment of an area about its axis	Students will be able to: ● Draw Free body diagram ● Know support designation ● Write equations using method of joints and method of sections ● Find the geometrical characteristics of sections	● Interactive Whiteboard Presentations ● Cooperative Group Investigations and Hands-on Labs ● Demonstrations ● Partner collaboration or individual work (depending on the topic and assignment.) ● Solving Real World Problems ● Students will draw free body diagram to show all the forces applied to a body ○ http://emweb.unl.edu/negahban/em223/note11/note11.htm ● Students will use different ways of solving trusses ○ http://emweb.unl.edu/negahban/em223/note12/note12.htm ○ http://emweb.unl.edu/negahb

		an/em223/note18/note18.htm ● Students will find the centroid and moment of inertia of different sections ○ http://emweb.unl.edu/negahban/em223/note19/note19.htm ○ http://www.physicsclassroom.com/class/vectors/u3l3c.cfm
Assessments:	**Materials:**	**Resources:**
● Performance based tasks ● Technology based presentation ● Observations, portfolios ● Homework ● Quizzes on each concepts ● Unit test ● Project-based learning	● Interactive Whiteboard ● TI-84-89+ Graphing Calculator ● TI SmartView Software ● Apparatus for Statics Experiments ● Beam Apparatus ● Experimental Set Deflection of Trusses ● Experimental Set Virtual work ● Tensile testing	● Mechanics of Materials Willey 2007(Ansel C. ugural) ● Mechanics of Materials 7th edition Prentice Hall (R.C. Hibber) ● Statics and Mechanics of Materials McGraw-Hill (Schaum's Outlines) ● YouTube presentations on equilibrium ○ http://www.youtube.com/watch?v=xrU3l1RvyiE&feature=related ○ http://www.youtube.com/watch?v=n1SQDmGDIDI ● College lectures on equilibrium ○ http://people.wallawalla.edu/~curt.nelson/engr221/lecture/lecture5x.pdf ○ http://www.youtube.com/watch?v=zJUTBZv3wi8 ○ http://www.youtube.com/watch?v=C4AsBDRQUUc&feat

		ure=related ○ http://pages.uoregon.edu/struct/courseware/461/461_lectures/461_lecture28/461_lecture28.html ○ http://mse.mcmaster.ca/undergraduate/courses/2H04/tasks/Centroid%20of%20Area%20and%20Moment%20of%20Inertia%20Calculation.pdf ○ http://www.solitaryroad.com/c375.html ○ http://www.newagepublishers.com/samplechapter/001777.pdf

Unit 3: Stress	Represent and solve problems involving normal, shear, and bearing stress
Timing:	4 weeks
Standards:	*NJSLS Technology* *8.2.12.A.1, 8.2.12.B.1, 8.2.12.B.2, 8.2.12.E.1, 8.2.12.F.2, 8.2.8.G.2, 8.2.12.G.1* *NJSLS Mathematics* Standards for MP 1-8

	NJSLS 21st Century Life and Careers: CRP1, CRP2, CRP4, CRP8, CRP11, CRP12	
Essential Questions:	**Objectives:**	**Activities, Investigation, and Student Experiences:**
• How to find the internal axial force? • What is Normal stress? • What is Shear stress? • What is Bearing stress? • How to design simple connections? • How to find stresses in simple structures? *Enduring Understandings* • Stresses can be found in 3 different forms • Method of sections is used in defining a general state of stress • Axial force diagram is used to show the internal axial force • Sign convention for tensile and compressive forces • Average stresses are used in design. • The average Bearing stress is computed using the projected area	Students will be able to: • Write equilibrium of a deformable body • Write equations to find the average normal , shear, and bearing stress in an axially loaded bar • Design of simple connections and find stresses in simple structures	• Interactive Whiteboard Presentations • Cooperative Group Investigations and Hands-on Labs • Demonstrations • Partner collaboration or individual work (depending on the topic and assignment.) • Solving Real World Problems • Students will work in groups to show how to solve stresses problems in bars ○ http://www.valpo.edu/student/asme/FE%20Slides/MechMatSlides.pdf ○ http://www.sut.ac.th/engineering/civil/courseonline/430211/Tanong/pdf/01_stress.pdf • Students will first find the reactions before isolating the body ○ http://www.mfge.atilim.edu.tr/Courses/mfge203_Mate/lecture%20notes/MFGE203_week_10-11-Lecture.pdf • Students will see presentations in

		solving stress problems on YouTube ○ http://www.youtube.com/watch?v=rsbChDVpuOU&playnext=1&list=PLD629BEA22548BA33 ○ http://www.youtube.com/watch?v=rsbChDVpuOU&playnext=1&list=PLD629BEA22548BA33 ○ http://www.youtube.com/watch?v=4FBaa82r_7A&feature=related ○ http://www.youtube.com/watch?v=3JVY1tngams&feature=related
Assessments:	**Materials:**	**Resources:**
● Performance based tasks ● Technology based presentation ● Observations, portfolios ● Homework ● Quizzes on each concepts ● Unit test ● Project-based learning	Interactive Whiteboard ● TI-84-89+ Graphing Calculator ● TI SmartView Software ● Apparatus for Statics Experiments ● Beam Apparatus ● Experimental Set Deflection of Trusses ● Experimental Set Virtual work ● Tensile testing	● Mechanics of Materials Willey 2007(Ansel C. ugural) ● Mechanics of Materials 7th edition Prentice Hall (R.C. Hibber) ● Statics and Mechanics of Materials McGraw-Hill (Schaum's Outlines

Unit 4: Strain and Mechanical Properties of Materials	Represent stress-strain relationship in tensile test	
Timing:	4 weeks	
Standards:	*NJSLS Technology* 8.2.12.A.1, 8.2.12.B.1, 8.2.12.B.2, 8.2.12.C.3, 8.2.12.D.1, 8.2.12.E.1, 8.2.12.F.2, 8.2.8.G.2, 8.2.12.G.1 *NJSLS Mathematics* Standards for MP 1-8 *NJSLS 21st Century Life and Careers:* CRP1, CRP2, CRP4, CRP8, CRP11, CRP12	
Essential Questions:	**Objectives:**	**Activities, Investigation, and Student Experiences:**
● What are the different forms of strain? ● What is the difference between displacement and deformation? ● How to draw the stress-strain diagram? ● How do ductile materials behave compare with brittle materials? ● How is Hooke's law is used in elasticity? *Enduring Understandings* ● Materials are deformed by Normal and Shear strain	Students will be able to: ● Know deformations of normal and shear strain ● Draw the stress-strain diagram for different materials ● Know the differences in stress-strain behavior of ductile and brittle materials ● Use Hooke's law and Poisson's ratio to solve strain problems	● Interactive Whiteboard Presentations ● Cooperative Group Investigations and Hands-on Labs ● Demonstrations ● Partner collaboration or individual work (depending on the topic and assignment.) ● Solving Real World Problems ● Students read notes on tensile test to derive the stress-strain relationship

● Measurements of strain are made by experiments ● Stress-strain diagram is used to explain the mechanical behavior of materials ● Ductile materials are used in tensile test ● The true stress and the true strain are increasing in tensile test ● Hooke's Law is used when the material behaves both elastically and linearly		○ http://stuff.mit.edu/afs/athena/course/3/3.225/book.pdf ● Students investigate the stress-strain relationship to write a linear equation ○ http://www.me.mtu.edu/~mavable/MEEM2150/Chap3.pdf http://files.asme.org/asmeorg/Governance/Volunteer/CareerSeries/9649.pdf ○ http://www.youtube.com/watch?v=0VYJup0g8H4 ○ http://www.youtube.com/watch?v=LEO9QqOJnHo&feature=related ● Students solve problems of deformations using Hooke's law ○ http://www.engineersedge.com/material_science/hookes_law.htm ● Students will see presentations in solving stress problems on YouTube ○ http://www.youtube.com/watch?v=o6RKK5B92Ag&feature=related ○ http://www.engineeringtoolbox.com/poissons-ratio-d_1224.html

		○ http://assakkaf.com/Courses/ENES220/Lectures/Lecture2.pdf ○ http://www.youtube.com/watch?v=G2kjsj0tiwc ○ http://www.youtube.com/watch?v=8mXWt3LkKZI&feature=related
Assessments:	**Materials:**	**Resources:**
● Performance based tasks ● Technology based presentation ● Observations, portfolios ● Homework ● Quizzes on each concepts ● Unit test ● Project-based learning	Interactive Whiteboard ● TI-84-89+ Graphing Calculator ● TI SmartView Software ● Apparatus for Statics Experiments ● Beam Apparatus ● Experimental Set Deflection of Trusses ● Experimental Set Virtual work ● Tensile testing	● Mechanics of Materials Willey 2007(Ansel C. ugural) ● Mechanics of Materials 7th edition Prentice Hall (R.C. Hibber) ● Statics and Mechanics of Materials McGraw-Hill (Schaum's Outlines

Unit 5: Torsion	Represent deformations and solve problems of axial and transverse shear stresses

Timing:	4 weeks	
Standards:	*NJSLS Technology* 8.2.12.A.1, 8.2.12.B.1, 8.2.12.B.2, 8.2.12.E.1, 8.2.12.F.2, 8.2.8.G.1, 8.2.12.G.2 *NJSLS Mathematics* Standards for MP 1-8 *NJSLS 21st Century Life and Careers:* CRP1, CRP2, CRP4, CRP8, CRP11, CRP12	
Essential Questions:	**Objectives:**	**Activities, Investigation, and Student Experiences:**
• How a twisted circular bar is deformed? • What are the basic assumptions associated with bars in torsion? • What type of stress is associated with torsion? • What is the torsion formula and how it is used? *Enduring Understandings* • Stresses and deformations in prismatic bars subject to torsion • Twisted rod can serve as spring offering rotational stiffness • The actual stress distribution closely approximates that given by the torsion formula • There is an analogy between the	Students will be able to: • Know torsion deformation of a circular shaft • Draw shear-strain distribution over the cross section • Use the torsion formula • Find angle of twist in tabular shaft	• Interactive Whiteboard Presentations • Cooperative Group Investigations and Hands-on Labs • Demonstrations • Partner collaboration or individual work (depending on the topic and assignment.) • Solving Real World Problems • Students analyze torsion deformations • Students working in groups to compare diagrams of stresses • Students solve problems of torsion using the torsion formula ○ http://www.freestudy.co.uk/c103/t3.pdf

analysis of axially loaded members and twisted members		○ http://www.engineeringtoolbox.com/torsion-shafts-d_947.html ○ http://www.assakkaf.com/Courses/ENES220/Lectures/Lecture6%20.pdf ○ http://www.freestudy.co.uk/c103/t3.pdf ○ http://portal.ku.edu.tr/~cbasdogan/Courses/MDesign/course_notes/ShearStressInBeamsNotes.pdf ● Students will see presentations in solving stress problems on YouTube ○ http://www.youtube.com/watch?v=yJXKoBTN0-U&feature=related
Assessments:	**Materials:**	**Resources:**
● Performance based tasks ● Technology based presentation ● Observations, portfolios ● Homework ● Quizzes on each concepts ● Unit test ● Project-based learning	● Interactive Whiteboard ● TI-84-89+ Graphing Calculator ● TI SmartView Software ● Apparatus for Statics Experiments ● Beam Apparatus ● Experimental Set Deflection of Trusses ● Experimental Set Virtual work ● Tensile testing	● Mechanics of Materials Willey 2007(Ansel C. ugural) ● Mechanics of Materials 7th edition Prentice Hall (R.C. Hibber) ● Statics and Mechanics of Materials McGraw-Hill (Schaum's Outlines)

Unit 6: Bending	Find the bending moment and shear force in any section then draw diagrams	
Timing:	5 weeks	
Standards:	*NJSLS Technology* 8.2.12.A.1, 8.2.12.B.1, 8.2.12.B.2, 8.2.12.E.1, 8.2.12.F.2, 8.2.8.G.1, 8.2.12.G.2 *NJSLS Mathematics* Standards for MP 1-8 *NJSLS 21st Century Life and Careers:* CRP1, CRP2, CRP4, CRP8, CRP11, CRP12	
Essential Questions:	**Objectives:**	**Activities, Investigation, and Student Experiences:**
● What are the different supports in beams? ● How beams are classified? ● How do you calculate beam reactions? ● How do you find shear force and bending moment in any section of the beam? ● What are the relationships between load, shear, and moment? ● How do you draw shear and moment diagram? *Enduring Understandings*	Students will be able to: ● Know the different types of beams and calculate reactions ● Find the shear force and bending moment in any section ● Draw shear and moment diagram to identify the maximum values ● Know all bending deformations of straight member ● Use the flexure formula	● Interactive Whiteboard Presentations ● Cooperative Group Investigations and Hands-on Labs ● Demonstrations ● Partner collaboration or individual work (depending on the topic and assignment.) ● Solving Real World Problems ● Students write equations of bending moment and shear ● Students draw diagrams of bending moment and shear and compare their

• The analysis of the force and moment distribution in a beam • Beams are classified by their supports • Static equilibrium is used to find the reactions of beams • A hinge is capable of transmitting a force with horizontal and vertical components • The variations of V and M along the beam are shown by algebraic equations • Shear and moment diagram to show the distributions along the beams		results • Solving problems of maximum loads and finding positions • Students will find the relationship between shear and moment ○ http://www.assakkaf.com/Courses/ENCE355/Lectures/Part2/Chapter8a.pdf ○ http://courses.washington.edu/me354a/chap3.pdf ○ http://www.freestudy.co.uk/engineering%20science%20h1/outcome%201%20t2.pdf ○ http://nptel.iitm.ac.in/courses/IIT-MADRAS/Strength_of_Materials/Pdfs/4_2.pdf
Assessments:	**Materials:**	**Resources:**
• Performance based tasks • Technology based presentation • Observations, portfolios • Homework • Quizzes on each concepts • Unit test • Project-based learning	• Interactive Whiteboard • TI-84-89+ Graphing Calculator • TI SmartView Software • Apparatus for Statics Experiments • Beam Apparatus • Experimental Set Deflection of Trusses • Experimental Set Virtual work • Tensile testing	• Mechanics of Materials Willey 2007(Ansel C. ugural) • Mechanics of Materials 7th edition Prentice Hall (R.C. Hibber) • Statics and Mechanics of Materials McGraw-Hill (Schaum's Outlines)

<table>
<tr><td>Unit 7: Stresses in Beams</td><td colspan="2">Solve problems of stress distribution in pure bending and shear and bending</td></tr>
<tr><td>Timing:</td><td colspan="2">3 weeks</td></tr>
<tr><td>Standards:</td><td colspan="2"><u>NJSLS Technology</u>
8.2.12.A.1, 8.2.12.B.1, 8.2.12.B.2, 8.2.12.E.1, 8.2.12.F.2, 8.2.8.G.1, 8.2.12.G.2

<u>NJSLS Mathematics</u>
Standards for MP 1-8

<u>NJSLS 21st Century Life and Careers:</u>
CRP1, CRP2, CRP4, CRP8, CRP11, CRP12</td></tr>
<tr><td>Essential Questions:</td><td>Objectives:</td><td>Activities, Investigation, and Student Experiences:</td></tr>
<tr><td>● What is pure bending in beam loading?
● How the beam is deformed under pure bending?
● What are the assumptions of beam theory?
● How to calculate shear stresses in circular and noncircular beams?
● How to use the flexure formula in computing the stresses?

Enduring Understandings

● Stresses in beams caused by bending moment and shear force
● Bending deflections will occur in</td><td>Students will be able to:

● Find beam deformations in pure bending
● Write the assumptions of beam theory
● Solve problems of normal strains, normal stress and shear stress
● Find shear stresses in flanged beams</td><td>● Interactive Whiteboard Presentations
● Cooperative Group Investigations and Hands-on Labs
● Demonstrations
● Partner collaboration or individual work (depending on the topic and assignment.)
● Solving Real World Problems
○ Students work in groups to identify bending deformations
○ Students solve problems of stresses and strains in</td></tr>
</table>

the same xy plane ● Equilibrium conditions, material behavior, and geometry of deformation are used for the bending stress formula ● The bending of the beam is treated as two dimensional problem ● The stress acting normal to the beam cross section is the flexural stress ● The flexure formula is used to the normal stress at any point of the section		noncircular beams ○ Students draw stress and shear distribution in cross sections ○ Design beams using the maximum stress and the permissible stress ○ http://pages.uoregon.edu/struct/courseware/461/461_lectures/461_lecture38/461_lecture38.html ○ http://www.assakkaf.com/Courses/ENES220/Lectures/Lecture9%20.pdf ○ http://www.optics.arizona.edu/optomech/references/OPTI_222/OPTI_222_W10.pdf ○ http://132.248.139.12/~solidos/Mec%E1nica%20de%20S%F3lidos%20(2)/LinkedDocuments/Chapter07.pdf
Assessments:	**Materials:**	**Resources:**
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