Pascack Valley Regional High School District Pascack Hills High School, Montvale, New Jersey 07645 Pascack Valley High School, Hillsdale, New Jersey 07642 **Course Name:** Calculus Born On: August, 2017 Previous Revision: August, 2020 Current Revision: August, 2023 Board Approval: 8/28/23

Course: Calculus PVRHSD CURRICULUM MAP Grade Level: 11 – 12

COURSE DESCRIPTION

Calculus is a full year, five credit course in calculus and related topics comparable to courses taught in colleges and universities. A prerequisite is the successful completion of *Precalculus*. The primary objective of this course is to prepare the student for Calculus in college. 11th and 12th grade students enrolled in Calculus have the option of earning college credit by registering with William Paterson University at a reduced price but at student expense. Please note that dual enrollment is not required, and that the course will have the same requirements and expectations whether or not students elect to register for college credit.

Each student who has mastered the concepts and skills in Calculus will exhibit competency with:

- 1. Polynomial, trigonometric, and exponential and logarithmic functions and function theory
- 2. The derivative of a function and applications
- 3. The antiderivatives of a functions and applications
- 4. Techniques of integration
- 5. The definite integral and applications

All mathematics courses in the Pascack Valley Regional High School District are designed to address multiple learning styles and needs, and accommodations and modifications are made for students with disabilities, multilingual students, students at risk of failure, gifted and talented students, and students with 504 plans. *Calculus* builds on concepts learned and skills developed in *Precalculus*, while also spiraling in those concepts and skills to reinforce and strengthen students' algebraic foundation. Additionally, *Calculus* anticipates higher-level mathematics that will be learned in college-level math and applied math courses, and enrichment opportunities are provided to challenge students and engage them in rich, interesting mathematics. Students are encouraged to analyze data using tools and models to make valid and reliable claims (9.4.12.IML.3), and various technologies are integrated throughout the curriculum, including scientific calculators, graphing calculators, specialized software, and various Internet programs and subscriptions. These tools enrich the curriculum by giving students' access to additional mathematical representations, and they also help to differentiate by providing students with additional options to engage with mathematical tasks.

The Pascack Valley Regional High School Mathematics Department integrates 21st century life and career skills across its courses, with the dual goal of informing students about careers and fields of study that use mathematics (9.3.ST.5, 9.3.ST-ET.5 and 9.3.ST-SM.2), and helping students improve the quantitative, mathematical, and statistical reasoning skills they will need to be effective producers and consumers of quantitative information in their everyday lives (9.2.12.CAP.2). Mathematics courses address the *New Jersey Student Learning Standards for Career Readiness, Life Literacies and Key Skills*, with a particular emphasis on demonstrating the ability to reflect, analyze and use creative skills and ideas (9.4.12.CI.1), investigating new challenges and opportunities for personal growth, advancement and transition (9.4.12.CI.3), identifying problem-solving strategies used in the development of an innovative product or practice (9.4.12.CT.1), and explaining the potential benefits of collaborating to enhance critical thinking and problem solving (9.4.12.CT.2). Mathematics courses also address the *New Jersey Student Learning Standards for English Language Arts Companion Standards*, with a particular focus on following complex multistep procedures (RST.9-10.3/RST.11-12.3), determining the meaning of symbols, key terms, and other domain-specific words and phrases (RST.9-10.4/RST.11-12.3), and translating quantitative or technical information expressed in words into visual forms and translating information expressed visually or mathematically into words (RST.9-10.7). Similarly, the mathematics department seeks to support students by providing them with opportunities to use quantitative, statistical, and mathematical reasoning in interdisciplinary contexts, in contexts that are meaningful to students, and in contexts that attend to the contributions and perspectives of

historically marginalized groups. Specifically, mathematics courses will look to incorporate, when appropriate, contributions and experiences of people from the LGBTQ+ community and individuals with disabilities, and references to issues of social and cultural relevance, including climate change.

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antiderivatives of a functions and applications, techniques of integration, and the definite integral and applications.

Content/Topic:	Key Learning Items/Concepts and Pacing Guide	Observable Proficiencies and Skills:	NJSLS	Formative, Summative, Benchmark, and Alternative Assessments	Core Instructional and Supplemental Materials/ Modifications and Accommodations
Unit 1 –	Key learning	A. Define: polynomial	NJSLS Content	Students will be	Selection of primary sources
Functions	items/concepts:	function.	Standards	assessed	Suggestion(s):
		B. Determine the	Calculus builds on many	regularly	Texts: Larson, Hostetler, Edward, Heath
Time: 3 weeks	- Polynomial/	existence, number, and	of the concepts and skills	throughout this	Calculus, 7th edition, 2002 (on grade level);
(see column 2 for	Rational/Algebraic (1	location of zeros of a	learned in the New Jersey	course, with a	Finney, Ross Calculus Graphical, Numerical,
a more detailed	day)	polynomial function.	Student Learning	focus on both	Algebraic, California: Scott Foresman
breakdown)	- Trigonometric (1 day)	C. Define the sine and	Standards	conceptual	Addison-Wesley Publishing Company, 1999.
	- Exponential/	cosine functions.		understanding	(advanced); Deltamath (remediation, on grade
	Logarithmic (1 day)	D. Utilize proficiently	NJSLS SMP	and procedural	level, and advanced)
	- General function	the fundamental and	MP1. Make sense of	fluency.	
	properties (1 day)	higher level	problems and persevere in	Assessment	Additional Resources:
	- Limits (including	trigonometric	solving them	tools may	Hughes- Hallett, Gleason, et al. Calculus Single
	one-sided limits) (1 week)	identities.	MP2. Construct viable	include the	Variable, 2nd Edition. New York: Wiley
	- Continuity (1/2 week)	E. Graph sine and	arguments and critique	following:	Publishing Company, Inc., 1998. Hockett, Bock,
	- Asymptotes (odd/even);	cosine functions,	the reasoning of others	- quizzes (F)	How to Prepare for the AP Calculus AP
	zeros (odd/even); slant	including variations of	MP3. Reason abstractly	- tests (S)	Examination 7th ed., Barron's, 2002.
	asymptotes (1/2 week)	$f(x) = A \sin(Bx + C)$	and quantitatively	- performance	Larson, Roland. Calculus with Analytic
		$and f(x) = A \cos(Bx)$	MP4. Model with	tasks (F/S)	Geometry, Third Edition. Massachusetts: D. C.
	Content-specific	+ <i>C</i>).	mathematics	- projects (S)	Heath and Company.
	modifications and	F. Formulate and	MP5. Attend to precision	- homework (F)	Stewart, James Calculus, 2nd Edition. New
	accommodations	interpret examples of	MP6. Use appropriate	- discussions	York: GWO Publishing Company, 2001. 1997,
	- this unit will spiral in	exponential and	tools strategically	(F)	1998, 2003 AP Calculus AB and BC Released
	concepts and skills that	logarithmic functions.	MP7. Look for and make	- journals (F)	exams, The College Board.
	students learned in	G. Graph exponential	use of structure	- Form A, B, or	Exploring Calculus with The Geometer's
	previous courses	and logarithmic	MP8. Look for and	C benchmark	Sketchpad® Key Curriculum Press, 2002.
	- differentiated problem	functions.	express regularity in	(B)	S o ftryogra
	sets can be used to	H. Explain and utilize	repeated reasoning	- alternative	Software:
	support and challenge	the inverse		assessments	Calculus in Motion

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 antiderivatives of a functions and applications, techniques of integration, and the definite integral and applications.						
students	relationship between	NJSLS for ELA	(A)	Geometric Sketchpad® v. 4.02, Key Curriculum		
	an exponential and a	Companion Standards	- Take home	Press, 2001.		
Interdisciplinary/additio	logarithmic function.	RST.9-10.3	exams and			
nal connections	I. Utilize e as a base,	RST.9-10.4	investigations	Calculators:		
- various graphs may be	where:	RST.9-10.7	(F)	The TI-83, TI-83+, TI-84, TI-89 or TI-92		
explored, including those	$-e = limit (1 + 1/x) ^x$	RST.11-12.3	- On-line work	graphing calculators (Texas Instruments).		
with contexts that draw on	- $limit (e^x - 1)/x = 1$	RST.11-12.4	including AP			
the experiences of diverse	x - > 0		exam open	Modifications and Accommodations:		
people and contexts that	J. Utilize these general	NJSLS-CLKS	ended questions	Students with special needs: Teachers and		
relate to climate change	function properties:	- 21st Century Life and	(F)	support staff will attend to all modifications and		
- problems may include	- Odd and even	Careers		accommodations listed in students' IEPs and		
applications in science or	- Sum, difference,	9.4.12.CI.1		504s. Teachers will incorporate manipulatives,		
engineering	product, and quotient	9.4.12.CI.3		extra time, alternative assessments, scaffolding,		
	- Composite functions	9.4.12.CT.1		spiraling, technology, and flexible grouping to		
	- Inverses	9.4.12.CT.2		support student learning.		
	K. Find the limit of a			Multilingual students: Teachers and support		
	function.	- Technology		staff will work to support multilingual students		
	L. Determine whether	9.4.12.IML.3		in their first language and in English, providing		
	and where a function			materials and/or resources to support students'		
	is continuous.	- Career Education		understanding. Students will be given additional		
	M. Asymptotes	9.2.12.CAP.2		time, as appropriate, and translation tools will be		
	(vertical, horizontal-	9.3.ST.5		utilized as needed.		
	including multiple,	9.3.ST-ET.5		Students at risk of school failure:		
	and slant)	9.3.ST-SM.2		Formative and summative data will be used to		
		NIGI G GGDT		monitor student success, and students at risk of		
		NJSLS – CSDT		failure will receive additional supports and		
		8.1.12.DA.1		services, which may include parent consultation,		
		8.1.12.DA.5		extra help, and differentiation strategies,		
		8.1.12.DA.6		including small group instruction, group work,		
		8.1.12.AP.1		scaffolding, and spiraling.		
		8.2.12.ETW.2		Gifted and Talented Students: Students who		
				excel in their mastery of course standards will be		
				further challenged with more complex tasks,		
				extensions of concepts and skills, and extended		
				problem solving and critical thinking		
				opportunities.		

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Content/Topic:	Key Learning Items/Concepts and Pacing Guide	Observable Proficiencies and Skills:	NJSLS	Formative, Summative, Benchmark, and Alternative Assessments	Core Instructional and Supplemental Materials/ Modifications and Accommodations
Unit 2 –	Key learning	A. Define: derivative	NJSLS Content	Students will be	Selection of primary sources
Differential	items/concepts:	B. Relate the concept	Standards	assessed regularly	Suggestion(s):
Calculus		of derivative to:	Calculus builds on many	throughout this	Texts: Larson, Hostetler, Edward, Heath
	A. The Derivative	1. Slope of a tangent	of the concepts and skills	course, with a focus	Calculus, 7th edition, 2002 (on grade level);
Time: 14-16	(presented graphically,	line	learned in the New Jersey	on both conceptual	Finney, Ross Calculus Graphical, Numerical,
weeks (see	numerically, and	2. Instantaneous	Student Learning	understanding and	Algebraic, California: Scott Foresman
column 2 for a	analytically) (8-9 weeks)	velocity	Standards	procedural fluency.	Addison-Wesley Publishing Company, 1999.
more detailed	1. Definition (3 days)	3. Rate of change of a		Assessment tools	(advanced); Deltamath (remediation, on
breakdown)	2. Applications (3 days)	function	NJSLS SMP	may include the	grade level, and advanced)
	3. Derivative at a point (2	C. Determine the	MP1. Make sense of	following:	
	days)	derivative of these	problems and persevere in	- quizzes (F)	Additional Resources:
	4. Derivatives of functions	functions:	solving them	- tests (S)	Hughes- Hallett, Gleason, et al. Calculus
	(5-7 days)	1. Polynomial	MP2. Construct viable	 performance tasks 	Single Variable,2nd Edition. New York:
	a. Polynomial/Rational	2. Trigonometric	arguments and critique	(F/S)	Wiley Publishing Company, Inc., 1998.
	b. Trigonometric	3. Exponential	the reasoning of others	- projects (S)	Hockett, Bock, How to Prepare for the AP
	c. Exponential	4. Logarithmic	MP3. Reason abstractly	- homework (F)	Calculus AP Examination 7th ed., Barron's,
	d. Logarithmic	D. Take derivatives of	and quantitatively	- discussions (F)	2002.
	4. Derivatives of sums,	sums, products, and	MP4. Model with	- journals (F)	Larson, Roland. Calculus with Analytic
	products, quotients (5 days)	quotients.	mathematics	- Form A, B, or C	Geometry, Third Edition. Massachusetts: D.
	5. Derivatives of composite	E. Use the Chain Rule	MP5. Attend to precision	benchmark (B)	C. Heath and Company.
	functions (3 days)	to take the derivative	MP6. Use appropriate	- alternative	Stewart, James Calculus, 2nd Edition. New
	6. Derivatives of implicitly	of a composite	tools strategically	assessments	York: GWO Publishing Company, 2001.
	defined functions (4 days)	function.	MP7. Look for and make	(A)	1997, 1998, 2003 AP Calculus AB and BC
	7. 2nd derivatives and their	<i>F. Take the derivative</i>	use of structure	- Take home exams	Released exams, The College Board.
	properties. (graphical and	of an implicitly defined	MP8. Look for and	and investigations	Exploring Calculus with The Geometer's
	numerical as well as	function.	express regularity in	(F)	Sketchpad® Key Curriculum Press, 2002.
	analytic) (2 days)	G. Complete related	repeated reasoning	- On-line work	
	8. Exponential	rate problems		including AP exam	Software:
	Differentiation (2 days)	H. Perform	NJSLS for ELA	open ended	Calculus in Motion

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instantaneous rates of change (2 days) 8. Related rates of chang days) Content-specific modifications and accommodations - just in time support wil	values of the function. P. Solve optimization Problems Q. Apply the derivative to motion 1 be along a line.	more complex tasks, extensions of concepts and skills, and extended problem solving and critical thinking opportunities.
incorporated to help students reinforce necess prerequisite skills - differentiated problem can be used to support as challenge students	equations sets	
Interdisciplinary/addit al connections - differential equations in include applications to science or engineering - position, velocity, and acceleration graphs will explored	nay	

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Content/Topic:	Key Learning Items/Concepts and Pacing Guide	Observable Proficiencies and Skills:	NJSLS	Formative, Summative, Benchmark, and Alternative Assessments	Core Instructional and Supplemental Materials/ Modifications and Accommodations
Unit 3 –	Key learning items/concepts:	A. Determine	NJSLS Content	Students will be	Selection of primary sources
Integral		antiderivatives.	Standards	assessed regularly	Suggestion(s):
Calculus	A. Antiderivatives (4 days)	B. Use	Calculus builds on many	throughout this	Texts: Larson, Hostetler, Edward, Heath
	B. Applications of	antiderivatives to:	of the concepts and skills	course, with a	Calculus, 7th edition, 2002 (on grade level);
Time: 15-16	antiderivatives (2 weeks)	1. Find distance	learned in the New Jersey	focus on both	Finney, Ross Calculus Graphical, Numerical,
weeks (see	1. Distance and velocity from	and velocity from	Student Learning	conceptual	Algebraic, California: Scott Foresman
column 2 for a	acceleration and initial	acceleration with	Standards	understanding	Addison-Wesley Publishing Company, 1999.
more detailed	conditions (3 days)	initial conditions.		and procedural	(advanced); Deltamath (remediation, on grade
breakdown)	2. Polynomial solutions of y (n)	2. Find	NJSLS SMP	fluency.	level, and advanced)
	= 0 (3 days)	polynomial	MP1. Make sense of	Assessment tools	
	3. Solutions of $y' = ky$ and $y' =$	solutions of y (n)	problems and persevere in	may include the	Additional Resources:
	c/x (applications to growth and	= 0	solving them	following:	Hughes- Hallett, Gleason, et al. Calculus Single
	decay) (3 days)	3. Solve	MP2. Construct viable	- quizzes (F)	Variable,2nd Edition. New York: Wiley
	C. Techniques of integration (3	differential	arguments and critique	- tests (S)	Publishing Company, Inc., 1998. Hockett,
	weeks)	equations, such as	the reasoning of others	- performance	Bock, How to Prepare for the AP Calculus AP
	1. Integration by substitution	$y'' = -(k \wedge 2) y$	MP3. Reason abstractly	tasks (F/S)	Examination 7th ed., Barron's, 2002.
	(5-7 days)	4. Solve equations	and quantitatively	- projects (S)	Larson, Roland. Calculus with Analytic
	2. Trigonometric integrals (2	like y ' = ky and y	MP4. Model with	- homework (F)	Geometry, Third Edition. Massachusetts: D. C.
	days)	'=c/x	mathematics	- discussions (F)	Heath and Company.
	3. Trigonometric substitution (3	C. Integrate by	MP5. Attend to precision	- journals (F)	Stewart, James Calculus, 2nd Edition. New
	days)	substitution, using	MP6. Use appropriate	- Form A, B, or C	York: GWO Publishing Company, 2001. 1997,
	D. The definite integral (3-4	identities and	tools strategically	benchmark (B)	1998, 2003 AP Calculus AB and BC Released
	weeks)	change of	MP7. Look for and make	- alternative	exams, The College Board.
	1. Concept of area (3 days)	variable.	use of structure	assessments	Exploring Calculus with The Geometer's
	2. Approximation of area (5-6	D. Relate the	MP8. Look for and	(A)	Sketchpad® Key Curriculum Press, 2002.
	days)	definite integral to	express regularity in	- Take home	
	a. Riemann Summations	the concept of	repeated reasoning	exams and	Software:
	b. Inscribed and circumscribed	area.		investigations (F)	Calculus in Motion
	rectangles	E. Use the definite	NJSLS for ELA	- On-line work	Geometric Sketchpad® v. 4.02, Key
	c. Trapezoids	integral to analyze	Companion Standards	including AP	Curriculum Press, 2001.
	3. Definition (2 days)	the concept of	RST.9-10.3	exam open ended	

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4. Properties (2 days)

area.

RST.9-10.4

questions (F)

Calculators:

antiderivatives of a functions and applications, techniques of integration, and the definite integral and applications.					
	4. Properties (2 days)	area.	RST.9-10.4	questions (F)	Calculators:
	5. Fundamental Theorem of	F. State and	RST.9-10.7	- Reimann sum	The TI-83, TI-83+, TI-84, TI-89 or TI-92
	Calculus (4 days)	explain definitions	RST.11-12.3	task (F)	graphing calculators (Texas Instruments).
	E. Application of the integral (4	and properties	RST.11-12.4	()	
	weeks)	related to the			Modifications and Accommodations:
	1. Comparison of total distance	definite integral.	NJSLS-CLKS		Students with special needs: Teachers and
	vs. displacement of velocity	G. State and	- 21st Century Life and		support staff will attend to all modifications
	functions	explain the First	Careers		and accommodations listed in students' IEPs
	2. Average value of a function	Fundamental	9.4.12.CI.1		and 504s. Teachers will incorporate
	on an interval (3 days)	Theorem of	9.4.12.CI.3		manipulatives, extra time, alternative
	3. Areas between curves (5	Integral Calculus.	9.4.12.CT.1		assessments, scaffolding, spiraling,
	days) using both dy and dx	H. Use the definite	9.4.12.CT.2		technology, and flexible grouping to support
	4. Volumes of solids of	integral to:			student learning.
	revolution (Discs and Washers)	1. Determine the	- Technology		Multilingual students: Teachers and support
	(6 days)	average value of a	9.4.12.IML.3		staff will work to support multilingual students
	5. Volumes of solids given	function on an			in their first language and in English,
	known cross sections (3 days)	interval	- Career Education		providing materials and/or resources to support
		2. Find areas	9.2.12.CAP.2		students' understanding. Students will be
	Content-specific modifications	between curves	9.3.ST.5		given additional time, as appropriate, and
	and accommodations	3. Find volumes of	9.3.ST-ET.5		translation tools will be utilized as needed.
	- technology will be utilized to	solids of	9.3.ST-SM.2		Students at risk of school failure:
	support students' understanding	revolution			Formative and summative data will be used to
	of area under the curve	Interpret 1n x as	NJSLS – CSDT		monitor student success, and students at risk of
	- differentiated problem sets can	the area under the	8.1.12.DA.1		failure will receive additional supports and
	be used to support and challenge	$graph\ of\ y=1/x$	8.1.12.DA.5		services, which may include parent
	students		8.1.12.DA.6		consultation, extra help, and differentiation
			8.1.12.AP.1		strategies, including small group instruction,
	Interdisciplinary/additional		8.2.12.ETW.2		group work, scaffolding, and spiraling.
	connections				Gifted and Talented Students: Students who
	- problems may include				excel in their mastery of course standards will
	applications to science or				be further challenged with more complex
	engineering				tasks, extensions of concepts and skills, and
	- position, velocity, and				extended problem solving and critical thinking
	acceleration graphs will be				opportunities.
	explored				