Mathematics 213 – 005: Analytic Geometry and Calculus III; Spring 2018

Class Schedule:	**Mon & Wed: 7:20 – 8:35 PM**	**Location:**	**Robinson B222**
Class Dates:	**Mon 22 Jan – Wed 2 May**	**Final exam:**	**Wed 9 May 7:30 – 10:15 PM in classroom**
Instructor:	**Mr. Glenn Preston**	**Email:**	**gpresto3@gmu.edu**
Office:	**Exploratory Hall, Room 4309**	**Office Hours:**	**Mon & Wed 4:00 – 6:00 PM and by appt.** *(best appointment times: Tues (10-5), Thu (10-2:30), Fri (10-3)*
Recitation Section 314:	**Wed 6:20 – 7:10, Robinson A208**		
Graduate Teaching Assistant:	**Ms. Tracey Oellerich**	**Email:**	**toelleri@masonlive.gmu.edu**
Office:	**Exploratory Hall, 4310/4311**	**Office Hours:**	**Tue 1:00 – 3:00 PM or by appointment**

Prerequisites:

- Grade of C or better in Math 114 ➔ In addition to a very good understanding of Analytic Geometry and Calculus I & II **you will need to have a SOLID foundation in basic geometry, algebra, trig, and other pre-calc topics**

Textbook and other Required Materials:

- **Calculus: Early Transcendentals, 2nd Edition, by Briggs, Cochran, and Gillet**, Pearson, 2015, ISBN: 9780321965165 (bundled with MyMathLab) or 9780321947345 (textbook only ➔ cheaper)
  - **You do not need MyMathLab** even though it is listed by the GMU Bookstore as "required" for this course. *(You may find it useful and are welcome to use it, but it is not required.)*
- **Student Solution Manual (SSM):** I recommend that you do NOT buy the SSM but of course it is your decision. I will provide my own solutions to all homework problems which will be much more explicit and tutorial than the SSM. I will also provide worked out solutions to selected even numbered exercises in the "class notes" to give you additional examples to help you get started and/or get unstuck when doing the homework. However, you are free to use the SSM if you have one, just make sure that you can actually DO the problems not just study the solutions.

Course Learning Objectives:

- **Catalog:** "Partial differentiation, multiple integrals, line and surface integrals, and three-dimensional analytic geometry."
- **Glenn's Additional Objectives:** Prepare you to be successful in future math, physics, science, engineering, and other courses that require analytic geometry and multivariate calculus; enhance your problem solving skills, intuition, and insight. Also, help you to be an effective and valued employee in your career field someday.

  Major points of emphasis will be to cultivate your skills to:
  - **(1) Analyze problems and solutions** to understand what they mean, how they behave, and when/how they are valid and keep out of trouble when a solution (or technique) is not valid
  - **(2) Do a "sanity check" to see if your answer makes sense** – e.g. does it have the correct properties? Does it fall within reasonable upper and/or lower bounds based on a "ball park" estimate or limiting case?
  - **(3) Graphing** - the name of this course is significant: "**Analytic Geometry** and Calculus III". This is NOT just a calculus course. We will extend single-variable calculus concepts and techniques to multi-dimensional problems, vectors, and vector fields. We will use calculus as a tool to help us **analyze** functions/solutions and determine their **geometric/graphical** properties so that we can graph solutions and/or the applicable regions of the problem

Approach: WE WILL EMPHASIZE THE FUNDAMENTALS

- **(1)** Learn how to **diagnose and "attack"** problems to **determine the problem type**, underlying **concept(s)**, appropriate problem solving **technique(s)**, and to master the **mechanics** of executing the solution
- **(2) Proofs and/or derivations of key theorems and techniques** – these are essential for learning and **understanding the "5Ws"** of what we are learning: the **"who, what, when, where, why, and how"** which is what you should focus on. We will do fewer proofs/derivations and generalized problems with parameters than when I took Calculus (i.e. the Stone Age) but more than you are probably used to. It can seem painful but it is worth it.

- **(3)** Include **fundamental concepts and techniques from prerequisite courses** in our Calc III problems to ensure that you have and maintain a solid foundation in geometry, algebra, trigonometry, functions, logs/exponentials, and single-variable calculus
- **(4) Emphasize graphing functions/solutions by hand** based on analysis of their properties. For almost any problem, there is an analytical (algebraic) view and a graphical (geometric) view. We'll try to learn both and understand the connection between them. This is traditionally a weak area for many students and I am always asked "Why do we have to graph by hand?" The reason is simple – it forces you to analyze the solution to determine its properties to synthesize a graph. This is a skill that is often not taught/practiced enough and is crucial to being a good problem solver, achieving a deeper understanding of what you are doing, and learning how to properly interpret your results.
- **(5) Word problems** – upper-level courses in your major (e.g. math, science, engineering, physics, economics, etc.) will be full of word problems so you need to get good at them, if not already. **Problem solving is both an art and a science.** Using an organized approach is vital to being a good problem solver. Doing enough problems of a particular type builds your intuition and insight into the best method(s) to "attack" similar problems. There is no substitute for **practice, practice, practice.**

Grades: Course Average Computation and Grade Scale

	Nominal	Max Final	Max Mid-term
Mid-term Exams	**60%** *(All 3 @ 20% each)*	**40%** *(best 2 @ 20% each)*	**75%** *(all 3 @ 25% each)*
Recitation Quizzes	**10%**	**10%**	**0%**
Final Exam	**30%**	**50%**	**25%**

- A course average will be calculated for each student using all four weightings. For each student, on an individual basis, I will use the highest average to determine the overall course grade using the grading scale below.

F (0.0)	D (1.0)	C- (1.67)	C (2.0)	C+ (2.33)	B- (2.67)	B (3.0)	B+ (3.33)	A- (3.67)	A (4.0)	A+ (4.0)	Letter Grade (Grade Points)
< 60	≥ 60	≥ 70	≥ 72	≥ 78	≥ 80	≥ 82	≥ 88	≥ 90	≥ 92	≥ 100	Course Average

- **Grades are based on an absolute scale and NOT using a "curve".** Your performance will be evaluated relative to what you need to achieve in order to be successful in future courses rather than relative to your classmates' performance (i.e. a curve). Exams will be designed accordingly and **you will have opportunities to earn extra credit on exams and quizzes**.
- **Speaking of Extra Credit: There are no extra credit assignments or other additional work during or at the end of the semester that can be done to boost your grade.** I still get asked every semester – and the answer is still "no".

QUIZZES & EXAMS:

- **MAKEUP QUIZZES & EXAMS: NONE EXCEPT CONSISTENT WITH GMU POLICY AS STATED BELOW**
  - **Missed quizzes and exams will receive a score of 0. There will be no makeup quizzes or exams except under special circumstances described below.**
  - **Per GMU Academic Policy A.P.1.6.1,** you may be able to take a quiz or mid-term exam at an alternate time **WITH PRIOR ARRANGEMENT**. This applies only to situations involving:

    (1) Religious Observance - I have done my best to deconflict the course schedule with religious holidays. However, if the schedule changes or there is a situation/conflict I am not aware of, please let me know.

    (2) Mandatory Participation in Official University Activities (e.g. intercollegiate athletics, GMU orchestra)

    My strong preference is to arrange the alternate time to be before the exam is given rather than allowing extra time to prepare.

    - If you have a conflict, please **let me know ASAP. Last minute requests (< 48 hours) will not be considered regardless of circumstances. Planning ahead is an important survival skill in the "real world".**
  - **If you have truly extraordinary circumstances – see me**. I'll listen but it needs to be a very good reason.

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- **OTHER QUIZ AND EXAM INFORMATION:**
  - **NO NOTES OR REFERENCES:** All exams and quizzes will be closed book and no notes or other reference material of any kind will be allowed. I may provide a reference sheet with some formulas, but most I expect you to know and/or be able to derive. I will let you know prior to the exam what, if any, reference material/formulas will be provided.
  - **NO CALCULATORS OR ELECTRONIC DEVICES OF ANY KIND WILL BE ALLOWED DURING EXAMS AND QUIZZES. Please turn-off (not just vibrate mode) and put away all cell phones, mp3 players, and any other electronic devices during quizzes and examinations.**
  - **FOOD & BEVERAGES:** Please no bags of chips, full-course meals, or other food that will make noise or otherwise distract fellow students. "Quiet" snacks are OK. Water and other non-alcoholic beverages are OK.

QUIZZES:

- **There will be a ~10 - 15 min quiz in the recitation most weeks** (see schedule). There will nominally be 14 quizzes. However many quizzes we have, say "N", I will divide your total by N-2 to get an average (➔two are extra credit).

MID-TERM EXAMS:

- **On all exams, regardless of topic, I will be looking for you to demonstrate:**
  1) **Good problem solving skills:** The ability to DIAGNOSE a problem to determine the type of problem, recognize and understand the FUNDAMENTAL CONCEPT(S) INVOLVED, determine and properly apply the APPROPRIATE PROBLEM SOLVING TECHNIQUE(S), and correctly EXECUTE THE MECHANICS technique(s)
  2) **Correct analysis, understanding, and interpretation of the solution:** For example:
     - Analyzing the properties/behavior of a solution to understand what it means, seeing if the solution passes a "sanity check" and/or estimating upper and/or lower bounds for the answer
       - Does the solution increase/decrease appropriately as a function of the variables and parameters?
       - Examine "limiting cases" (i.e. as parameters and/or variables go to 0 or ∞, etc.).
     - Does the solution match given conditions and/or satisfy physical constraints of the problem?
     - Is the solution defined over the appropriate domain and does it produce the appropriate range?
     - Estimate "ball park" values using simpler conditions (e.g. round numbers, simpler curves/shapes)
  3) **Ability to graph/sketch the solution** – use calculus and other techniques to deduce properties of the solution and correctly draw it; relate the graphical behavior of the solution to expected results based on the type of problem, specified conditions/parameters, physical constraints, etc.
  4) **A well-organized solution with a mathematically correct progression from each step to the next**
     - **SHOW YOUR WORK**; don't leave large gaps between steps, be careful with use of an equal sign ➔ both sides must truly be equal or else it is an incorrect statement; be careful with notation (e.g. don't leave off "dx" from integrals).
     - **WHAT YOU WRITE DOWN MATTERS** - even if you understand what you are doing, you need to properly communicate that understanding to me (and later to coworkers, customers, your boss, etc.)
- **Regardless of the chapter topic, each exam will also have at least one or more problems involving:**
  - **Word problem(s)** and/or physical application(s)
  - Some form of **transcendental function(s)** (e.g. trig and/or inverse trig functions, log and exponential functions)
  - **Parametric values** and analysis of how solutions behave relative to the parameters of the problem
  - **Application of fundamentals:** geometry, trigonometry, and algebra concepts and techniques
  - **Graphing** of function(s) and/or solution(s)

COMPREHENSIVE FINAL EXAM:

- The emphasis will be on key concepts/techniques, particularly putting them together to solve "compound" problems, applications, and understanding of the "big picture" and "the 5W's"
  - **IMPORTANT NOTE:** Per GMU Policy A.P.3.10, you must take the final exam at the regularly scheduled date and time unless you have **excused absence in writing signed by your Dean or Academic Director.**

- GMU policy allows you to arrange an alternate day/time if you have a conflict between final exams or more than two final exams on one day. If so, **let me know SEVERAL WEEKS PRIOR to the final exam.**

Honor Code: THIS IS VERY IMPORTANT

- **It is expected that each student in this class will conduct himself or herself within the guidelines of the Honor Code.** Among other things, this means that sharing information of any kind about exams or quizzes (either before or during the exam) is forbidden. Any alleged issues related to the honor code will be brought to the attention of the Office of Academic Integrity. Please reread the University Honor Code and abide by it.

My Commitment to you:

- So far all of the rules have been imposed on you. However, you have a right to expect certain things from me as well. I have responsibilities to each student and to the class as a whole. My commitment to the class is that I will:
  - Do my best to follow my own advice/rules and lead by example – i.e. I will try to "practice what I preach"
  - Be as honest, open, and transparent as possible in how I conduct the class, consistent with maintaining proper student privacy/confidentiality and the academic integrity of the course.
  - Treat every student with respect and as an individual having individual talents and needs, within the constraints of doing what is best for the class as a whole. Everyone learns a little differently and some students need more help than others.
  - **Bottom line: To be successful in this course you will need to do more than just the bare minimum ➔ I am therefore ready, willing, and able to do more than the minimum required of me** *(e.g. extra office hours, review sessions, provide supplemental material, whatever I can do to help students realize their potential)*

Homework Exercises:

- **WORD TO THE WISE: If you don't do a thorough and comprehensive job on the homework exercises, you will almost certainly fail the course – it is that simple. Many have tried (myself included) to short-change the homework and it always ends VERY badly.**

Getting Help:

- **Don't let a small problem turn into a big one by getting behind – it will be very difficult to catch up**.
  - **Contact me** via email and/or come see me during regular office hours or make an appointment.
  - **The Math Tutoring Center**, Johnson Center, Room 344: http://math.gmu.edu/tutor-center.php
  - **Find a buddy and/or form a study group** – there is nothing wrong with working collaboratively. However, make sure that you don't simply "go along for the ride" when working with someone. **Watching someone else do a problem – even if you understand what they are doing – is not the same as doing it yourself**
  - **Internet Resources:** There is tons of good stuff and here are a few I like:
    - **Class notes by Paul Dawkins (Lamar University)**
      - These are tutorial in nature, quite readable, and the topics covered are nearly identical to the ones we cover in our course. You can view these notes on-line and/or download PDF files (whole course, by chapter, or by selected topic(s)) http://tutorial.math.lamar.edu/Classes/CalcIII/CalcIII.aspx
    - **The Kahn Academy Tutorials**
      - In general I find Kahn academy videos pretty good. Here is a link to the multivariable calculus table of contents: https://www.khanacademy.org/math/multivariable-calculus#table-of-contents
    - **MIT Open Courseware (OCW)**
      - There are several versions of courses covering multivariable calculus with varying degrees of theory (course numbers 18.02SC, 18.02, 18.022, 18.024). Here is a link to the MIT OCW calculus page: http://ocw.mit.edu/courses/find-by-topic/#cat=mathematics&subcat=calculus
    - **Mathematica Demos**
      - http://demonstrations.wolfram.com/ There are ~550 interactive calculus demos and 58 are tagged as multivariate: http://demonstrations.wolfram.com/search.html?query=multivariate%20calculus

- Some demos are pretty good and some are pretty arcane and/or nerdy. I will use Mathematica to help us visualize problems and solutions, and I will post the files on Blackboard.

Class Web Page/Communication:

- I will post all class materials, announcements, scores/grades on **Blackboard** and send some things via GMU email.
- **The primary way to contact me is via GMU email (gpresto3@gmu.edu)**
  - To comply with GMU policy and protect your privacy, I will try to only send email to your GMU email address. **Please only send email to me from your GMU email so I can use the "reply" function in responding to you**.
  - I will try to reply to each email ASAP, but please bear in mind that it may not be until after "close of business". As an alternate means of contact, you can call or text (703) 405-0344. I work full-time outside of GMU and have limited cell phone and email access during normal business hours so please be patient.

Mathematica Computer Algebra Systems (CAS) Software – FREE access:

- **One of the most difficult aspects of this course is getting comfortable working in multiple dimensions.** We will extend our calculus knowledge from functions of a single variable (i.e. a domain that is a subset of the number line) to functions of multiple independent variables (i.e. a domain that is a subset of a plane (2-dimensions or R^2), and 3-dimensions or R^3). Vectors and vector calculus can also be hard to grasp at first. Mathematica can help you make this leap by helping you to visualize and understand problems, concepts, and techniques that otherwise can be difficult to visualize. There are no Mathematica projects in this course but now that you know how to use it from Math 113 & 114, Mathematica can be a very helpful learning tool.

Other Topics:

- **Class Schedule:** The last page shows the nominal schedule for lecture topics, quizzes, exams, etc. Modifications to the schedule may be required. **You are responsible for being aware of any announced, emailed, and/or posted changes. Please check the syllabus before asking "what is on the quiz this week?"**
- **Attendance: Will not be taken and there is no "participation" component to your grade.** It is your choice/responsibility to show up for class, be prepared, and get something out of it. **REGARDLESS, IT IS VITAL THAT YOU KEEP PACE WITH THE COURSE SCHEDULE.**
- **Electronic devices: Please be courteous and silence all cell phones, pagers, iPods, and other devices during class.** You may use a laptop, smartphone, or other electronic device for capturing notes or other legitimate class related use (but NOT during an exam or quiz). **Basic principle:** Please use common sense and avoid disrupting the class and/or distracting other students.
- **University Policies:** Please familiarize yourself with university policies. The University Catalog, http://catalog.gmu.edu, is the central resource for university policies affecting student, faculty, and staff conduct in university academic affairs. All members of the university community are responsible for knowing and following established policies and procedures. (See also http://universitypolicy.gmu.edu/)

Other University Resources and Links:

- **Office of Disability Services** (ODS): Student Union Building I, Room 211, (703) 993-2474**.** All academic accommodations must be arranged through ODS. If you are a student with a disability and need academic accommodations, please contact ODS as soon as possible and do not hesitate to speak confidentially with me.
- **Counseling And Psychological Services** (CAPS): Student Union Building I, Rm 3129, (703) 993-2380
- **Veterans: Office of Military Services:** SUB I, Suite 1510 (next to Chik-Fil-A) , (703) 993-1316
- **Mathematical Sciences Department**: Exploratory Hall room 4400, (703) 993-1460

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***** Class Lecture/Exam/Quiz Schedule (Subject to Change) *****

Unless there are class cancellations we will stick to this schedule. Quizzes and exams will cover scheduled sections regardless of how much of any particular chapter section we cover during each lecture.

Prior to Each Class:

- **GOOD:** Make sure you have completed homework from all prior chapter sections. Seek help as needed.
- **BETTER:** Read upcoming section(s). WORK THROUGH THE EXAMPLES IN THE TEXT
- **BEST:** Try the homework for the upcoming section(s): Do what you can, make a list of questions for the rest.

Course Schedule

	MONDAY	WEDNESDAY	
	Lecture	Recitation	Lecture
1	22 JAN	24 JAN	
	11.1, 11.2	Intro, **Quiz-1**	11.2, 11.3
2	29 JAN	31 JAN	
	11.4, 11.5	**Q2:** 11.1 – 11.3	11.5, 11.6
3	5 FEB	7 FEB	
	11.7, 11.8	**Q3:** 11.4 – 11.6	11.8, 11.9
4	12 FEB	14 FEB	
	Ch. 11 Review	**Q4:** 11.7 – 11.9	**EXAM-1 Ch. 11**
5	19 FEB	21 FEB	
	12.1, 12.2	**Q5:** 12.1 – 12.2	12.2, 12.3
6	26 FEB	28 FEB	
	12.4, 12.5	**Q6:** 12.2 – 12.3	12.5, 12.6
7	5 MAR	7 MAR	
	12.7, 12.8	**Q7:** 12.4 – 12.6	12.8, 12.9
8	12 MAR	14 MAR	
	SPRING BREAK, NO CLASSES		
9	19 MAR	21 MAR	
	Ch. 12 Review	**Q8:** 12.7 – 12.9	**EXAM-2 Ch. 12**
10	26 MAR	28 MAR	
	13.1, 13.2	**Q9:** 13.1 – 13.2	13.2, 13.3
11	2 APR	4 APR	
	13.4	**Q10:** 13.2 – 13.3	13.5, 13.7
12	9 APR	11 APR	
	Ch. 13 Review	**Q11:** 13.4 – 13.7	**EXAM-3 Ch. 13**
13	16 APR	18 APR	
	14.1, 14.2	**Q12:** 14.1 – 14.2	14.2, 14.3
14	23 APR	25 APR	
	14.4, 14.5	**Q13:** 14.2 – 14.3	14.5, 14.6
15	30 APR	2 MAY	
	14.7	**Q14:** 14.4 – 14.5	14.8

COMPREHENSIVE FINAL EXAM
WED 9 MAY 7:30 – 10:15 PM
Robinson B222 (classroom)

Homework Exercises (x – y = ODD ONLY; Even in bold italic)

Ch	Title	Exercises
	11: VECTORS AND VECTOR-VALUED FUNCTIONS	
11.1	Vectors in the Plane	21 – 25, 31, 37, 39, 43, 45, 47, 51, 59, 67, 77, 79
11.2	Vectors in 3-Dimensions	13, 19 – 25, 31, 33, 45, 53, 57, 71, 75
11.3	Dot Products	19 – 23, 29, 33, 37, 45 – 49, 59 – 65, 69, 83, 85
11.4	Cross Products	11, 15, 19, 23, 29 – 35, 41, 49 – 55, 59, 65
11.5	Lines & Curves in Space	9, 13, 21, 25 – 31, 35, 41, 43, 47, 51, 63 – 67, 75
11.6	Calculus of Vector-Valued Functions	9, 17, 23 – 27, 35, 37, 41, 43, 49, 55, 57, 65, 67, 79, 89
11.7	Motion in Space	9, 11, 15, 17, 21, 25, 27, 33 – 37, 41, 45, 51, 53, 59 - 63
11.8	Length of Curves	11, 13, 17, 23, 25, 31, 35, 37, 51, 57
11.9	Curvature & Normal Vectors	11 – 15, 27 – 31, 35, 37, 49, 61
	12: FUNCTIONS OF SEVERAL VARIABLES	
12.1	Planes and Surfaces	11, 13, 17, 19, 29, 33, 37, 43 – 47, 51, 55, 59, 71, 79, 95
12.2	Graphs and Level Curves	11, 15, 17, 21 – 25, 29, 33, 35, ***38***, 53, ***54***
12.3	Limits and Continuity	15 – 19, 23 – 29, ***30***, 45, 49, 53, 55, 59, 61, 69
12.4	Partial Derivatives	11, 15, 17, 23, 29, 33, 41 – 47, 59, 77, ***82***, 85
12.5	The Chain Rule	11 – 17, 21 – 25, 31, 33, 39, 41, 57, 61
12.6	Directional Derivatives and the Gradient	9, 11, 19, 21, 27, 29, 33, 39, 43, 53, 55, 63, 65
12.7	Tangent Planes and Linear Approximation	11, 13, 17, 21, 25, 27, 35, 39, 45, 47, 51
12.8	Max/Min Problems	19 – 27, 35, 43, 45, 57, 61, 67
12.9	Lagrange Multipliers	5, 11 – 15, 19, 23, 25, 29, 33, 39, 47, 51, 57
	13: MULTIPLE INTEGRATION	
13.1	Double Integrals over Rectangular Regions	7 – 11, 15, 21, 23, 29 – 37, 38, 47, 51
13.2	Double Integrals over General Regions	11, 19, 21, 27 – 31, 37, 39, 49, 53, 57, 63 – 67, 71, 75, 81, 93
13.3	Double Integrals in Polar Coordinates	11, 15, 19, 23, 25 – 29, 37, 45, 49, 51, 59, 65
13.4	Triple Integrals	9, 13 – 23, 31, 35, 39, 43, 45, 49, 53, 61
13.5	Triple Integrals in Cylind. & Spherical Coordinates	13 – 17, 21, 23, 29, 37 – 41, 47, 51, 53, ***64***, 65, 67
13.7	Change of Variables in Multiple Integrals	5 – 9, 13 – 23, 27 – 41, 45, 46, 47
	14: VECTOR CALCULUS	
14.1	Vector Fields	9 – 13, ***16***, 17 – 25, 29, 35, 37, 41, ***42***, 43
14.2	Line Integrals	11, 13, 17, 19, 23, 25, 27, 31 – 39, 43, 47, 51
14.3	Conservative Vector Fields	11, 15, 17, 21, 23, 27, 29, 33, 35, 39, 41, 49, 51, 53
14.4	Green's Theorem	11 – 19, 23 – 31, 35, 39
14.5	Divergence and Curl	9, 13, 17, 21, 27 – 31, 39, 41, 53 – 59
14.6	Surface Integrals	11 – 17, 27, 31 – 39, 49
14.7	Stokes' Theorem	5, 7, 11, 13, 17, 19, 23, 25
14.8	Divergence Theorem	9 – 19, 27, 31