VECTOR CALCULUS
MATH 21D, Winter Quarter, 2023
Blake Temple
(Sects B01-B08 CRNs 30764-30770,45814)

TEXT: *Thomas' Calculus, Early Transcendentals, 11th Edition (Ch 13,15,16 available on my webpage)*
Authors: Weir, Hass and Giordano
Chapters: 15 and 16 (including topics from Chapter 12, 13).
PROFESSOR: Blake Temple, 3148 MSB
Lecture: 1020 TLC, MWF 5:10-6:00
Office Hours: WF 3:15-4:30; **e-mail:** temple@math.ucdavis.edu
Class Webpage: http://www.math.ucdavis.edu/∼ temple/MAT21D/

Thursday Discussion Sections: (Handled by TA's)
B01 1344 Storer, R7-8:SG; **B02** 205 Olsen, R6-7:CD; **B03** 1344 Storer, R6-7:JD; **B04** 1006 GIEDT, R5-6:JD; **B05** 108 HOAGLD, R5-6:AR; **B06** 1006 GIEDT, R4-5:AR; **B07** 108 HOAGLD, R6-7:MC; **B08** 108 HOAGLD, R3-4:SD.

GRADING: Midterms I,II=100pts each, Final =200pts.
Midterm I: Friday, February 3, Sections 15.1-15.7
Midterm II: Friday, Mar 10, Sections 13.1-13.4, 16.1-16.6
Final Exam: Tuesday, March 21, 10:30-12:30, 1020 TLC

HOMEWORK/Solutions Posted Online:
https://www.math.ucdavis.edu/ temple/MAT21D
HW will *not be collected*. There will be a weekly homework quiz each Thursday discussion covering the homework from the preceding week. No makeups. I will use the homework score to (at most) adjust a grade by + or − according to my judgement.

SYLLABUS

DAY	SECTION	HOMEWORK
MO – Jan 9	**Introduction/15.1**	**15.1**−1, 2, 4, 5, 7, 9, 13, 21, 23, 38
WE – Jan 11	**15.1**	**15.1**−41, 43, 44, 45, 46, 51, 59
FR – Jan 13	**15.2**	**15.2**−2, 3, 7, 9, 11, 12
MO – Jan 16	**Martin Luther King Day**	
WE – Jan 18	**15.2**	**15.2**−14, 15a, 17, 19, 24, 33, 34
FR – Jan 20	**15.3**	**15.3**−1, 3, 4, 12, 13, 18
MO – Jan 23	**15.4**	**15.4**−7, 8, 11, 12, 17, 42
WE – Jan 25	**15.5**	**15.5**−2, 3, 4, 11, 13, 15
FR – Jan 27	**15.6**	**15.6**−1, 6, 8, 18, 19, 44, 56
MO – Jan 30	**15.6 – 15.7**	**15.6**−21, 27, 35, 56, 70
WE – Feb 1	**15.7**	**15.7**−1, 4, 6, 8, 12, 15a, 16ab
FR – Feb 3	**Midterm I**	
MO – Feb 6	**13.1**	**13.1**−1, 3, 4, 6, 8, 10, 12, 13, 19, 33, 43, 45, 48
WE – Feb 8	**13.2**	**13.2**−1, 2, 3, 5, 7, 11, 18
FR – Feb 10	**13.3**	**13.3**−1, 3, 6, 9, 12, 14, 19, 20
MO – Feb 13	**13.4** (**12ed13.4/5**)	**13.4**−2, 3, 9, 11, 19, 21
WE – Feb 15	**16.1**	**16.1**−1 − 8, 10, 17, 18, 29
FR – Feb 17	**16.2**	**16.2**−1, 3, 4, 5, 6, 7, 15, 20, 22, 31, 35
MO – Feb 20	**Presidents′ Day**	
WE – Feb 22	**16.2**	**16.2**−17, 23, 27, 37, 43
FR – Feb 24	**16.3**	**16.3**−1, 2, 3, 7, 9, 13, 19, 37
MO – Feb 27	**16.4**	**16.4**−1, 5, 7, 8, 11
WE – Mar 1	**16.4/5**	**16.4**−15, 19, 22
FR – Mar 3	**16.5**	**16.5**−1, 3, 5, 6, 7, 13, 15, 17, 19, 21, 24, 27
MO – Mar 6	**16.6**	**16.6**−1, 4, 5, 9, 17, 27, 30, 39
WE – Mar 8	**Review/Catchup**	
FR – Mar 10	**Midterm II**	
MO – Mar 13	**16.7**	**16.7**−1, 3, 6, 7
WE – Mar 15	**16.7/8**	**16.7**−8, 13, 17 **16.8**−5, 6, 7
FR – Mar 17	**16.8**	**16.8**−8, 14, 16, 26

Lead TA: Casey Duckwall: csduckwall@math.ucdavis.edu;

- Jeshu Dastidar: jdastidar@ucdavis.edu;
- Angel Manuel Rodriguez Lopez: arodriguezlopez@ucdavis.edu;
- Matthew Corbelli: mdcorbelli@ucdavis.edu;
- Sanchayan Dutta: dutta@ucdavis.edu;
- Soumyajit Ganguly: sgganguly@ucdavis.edu

COURSE DESCRIPTION:

Math 21D *Vector Calculus* describes the calculus of functions whose inputs and outputs depend on more than one variable. Chapter 15 covers multiple integration for scalar functions of two and three variables, with application to finding centers of mass and moments of inertia. Integration in polar, cylindrical and spherical coordinates will be covered, as well as the general formula for changing variables of integration. Chapters 13 and 16 cover vector valued functions (*Vector Fields*). Applications include line integrals, work, conservative vector fields, potential functions, Green's Theorem, the Divergence Theorem and Stokes Theorem. The latter four involve different ways to generalize the Fundamental Theorem of Calculus to vector valued functions.

HISTORY/MOTIVATION: Essentially, MAT21D covers the mathematics required to complete the physical meanings of the three first order operators of classical physics: The *Gradient*, the *Divergence* and the *Curl*. We already know that the Gradient points in the direction of steepest increase of a function. The meaning of the latter two, the *Divergence* as *flux per volume*, and the *Curl* as *circulation per area*, comes from the *Divergence Theorem* and *Stokes Theorem*, respectively; and the mathematics

developed in MAT21D is pretty much exactly what is necessary to describe and interpret these theorems with mathematical precision. The notation of vector calculus in terms of the Gradient, Divergence and Curl was created by Willard Gibbs of Yale University in the late 1800s. By this notation, Gibbs achieved his goal of giving a simple physical expression to Maxwell's equations of electromagnetism (1861). With the vector calculus of MAT21D, Gibbs reduced Maxwell's original twenty equations in twenty unknowns, to the four famous equations we know today. The student who learns the vector calculus of MAT21D has the mathematical background to comprehend Maxwell's theory, and thereby has the opportunity to be a part of one of the greatest true stories of all time—the story of how Maxwell, building on Faraday's idea that electricity and magnetism could be described by electric and magnetic *Vector Fields*, discovered, by pure thought, that light consists of waves propagating in these electric and magnetic fields. To quote from Wikipedia:

Around 1862, while lecturing at King's College, Maxwell calculated that the speed of propagation of an electromagnetic field is approximately that of the speed of light. He considered this to be more than just a coincidence, and commented 'We can scarcely avoid the conclusion that light consists in the transverse undulations of the same medium which is the cause of electric and magnetic phenomena.'

Maxwell's theory of light remained controversial until 1887, when Heinrich Hertz demonstrated that radio waves could be created from oscillating electric and magnetic fields.

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