**VECTOR CALCULUS**
**MATH 21D, Spring Quarter, 2016**
**Blake Temple-Dan Romik**
**(Sects B01-B02 CRNs 63357-63358)**

**TEXT:** *Thomas' Calculus, Early Transcendentals, 11th Edition (Text easily found online)*
**Authors:** Weir, Hass and Giordano
**Chapters:** 15 and 16 (including topics from Chapter 12, 13).
**PROFESSOR:** Blake Temple, 3148 MSB, 752-2214
**Lecture:** 119 Wellman, MWF 3:10-4:00
**Office Hours:** MWF 1:30-2:30 or after class
**e-mail:** temple@math.ucdavis.edu
**Class Webpage:** http://www.math.ucdavis.edu/∼ temple/MAT21D/

**THURSDAY DISCUSSION SECTION:**
**TA:** Yang Lee, 113 HOAGLAND HALL, 5:10-6:00 PM
**GRADING:** Midterms I,II=100pts each, Final =200pts.
**Midterm I:** Wednesday, April 20, Sections 15.1-15.7
**Midterm II**: Wednesday, May 18, Sections 13.1-13.4, 16.1-16.5
**Final Exam (H):** Wednesday June 8, 8-10am 119 Wellman

**HOMEWORK: Problems/Solutions Posted Online**:
https://www.math.ucdavis.edu/ temple/MAT21D
HW will *not be collected*, but there will be a weekly homework quiz in each Tuesday discussion section covering the homework from the preceding week. I will use the homework score to (at most) adjust a grade by + or − according to my judgement. There will be no makeup of homework or exams.

## SYLLABUS

| DAY | SECTION | HOMEWORK |
|---|---|---|
| MO – Mar 28 | **Introduction/15.1** | **15.1**−1, 2, 4, 5, 7, 9, 13, 21, 23, 38 |
| WE – Apr 30 | **15.1** | **15.1**−41, 43, 44, 45, 46, 51, 59 |
| FR – Apr 1 | **15.2** | **15.2**−2, 3, 7, 9, 11, 12 |
| MO – Apr 4 | **15.2** | **15.2**−14, 15a, 17, 19, 24, 33, 34 |
| WE – Apr 6 | **15.3** | **15.3**−1, 3, 4, 12, 13, 18 |
| FR – Apr 8 | **15.4** | **15.4**−7, 8, 11, 12, 17, 42 |
| MO – Apr 11 | **15.5** | **15.5**−2, 3, 4, 11, 13, 15 |
| WE – Apr 13 | **15.6** | **15.6**−1, 6, 8, 18, 19, 44, 56 |
| FR – Apr 15 | **15.6 – 15.7** | **15.6**−21, 27, 35, 56, 70 |
| MO – Apr 18 | **15.7** | **15.7**−1, 4, 6, 8, 12, 15a, 16ab |
| WE – Apr 20 | **Midterm I** | |
| FR – Apr 22 | **13.1** | **13.1**−1, 3, 4, 6, 8, 10, 12, 13, 19, 33, 43, 45, 48 |
| MO – Apr 25 | **13.2** | **13.2**−1, 2, 3, 5, 7, 11, 18 |
| WE – Apr 27 | **13.3** | **13.3**−1, 3, 6, 9, 12, 14, 19, 20 |
| FR – Apr 29 | **13.4** (**12ed13.4/5**) | **13.4**−2, 3, 9, 11, 19, 21 |
| MO – May 2 | **16.1** | **16.1**−1 − 8, 10, 17, 18, 29 |
| WE – May 4 | **16.2** | **16.2**−1, 3, 4, 5, 6, 7, 15, 20, 22, 31, 35 |
| FR – May 6 | **16.2** | **16.2**−17, 23, 27, 37, 43 |
| MO – May 9 | **16.3** | **16.3**−1, 2, 3, 7, 9, 13, 19, 37 |
| WE – May 11 | **16.4** | **16.4**−1, 5, 7, 8, 11 |
| FR – May 13 | **16.4 – 16.5** | **16.4**−15, 19, 22 |
| MO – May 16 | **16.5** | **16.5**−1, 3, 5, 6, 7, 13, 15, 17, 19, 21, 24, 27 |
| WE – May 18 | **Midterm II** | |
| FR – May 20 | **16.6** | **16.6**−1, 4, 5, 9, 17, 27, 30, 39 |
| MO – May 23 | **16.7** | **16.7**−1, 3, 6, 7 |
| WE – May 25 | **16.7 – 8** | **16.7**−8, 13, 17 **16.8**−5, 6, 7 |
| FR – May 27 | **16.8** | **16.8**−8, 14, 16, 26 |
| MO – May 30 | **MemorialDay** | |
| WE – Jun 1 | **Review/Catchup** | |

## 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.

Blake Temple
UC-Davis
March 20, 2016