ESC195S Calculus II
COURSE OUTLINE, Winter 2023
(As of February 15, 2023)

Instructor:
James W. Davis
Institute for Aerospace Studies
Main Campus office: SF4002
Phone (UTIAS): 416-667-7868
email: james.davis@utoronto.ca

Lectures :

Section 1			**Section 2**		
Monday	4-5	MP102	Monday	5-6	MP202
Thursday	11-12	KP108	Thursday	12-1	KP108
Friday	2-3	MP203	Friday	4-5	MP203

As a courtesy to other students, we request that cellphones be kept on silent, and placed "out of sight" during all lectures and tutorials.

Tutorials: (Jan 18 start)

Wdenesday	12-1	T1 (Isaac, BA2159), T2 (Ali, BA2139), T3 (Jeffrey, BA2195)
	1-2	T10 (Ines, BA2139), T11 (George, HA403), T12 (Rajat, BA2159),
	5-6	T4 (Ines, BA2165), T5 (Jeffrey, BA2195), T6 (George, HA401)
		T7 (Ali, WB219), T8 (Isaac, HS108), T9 (Rajat, GB303)

Textbook: Stewart, Clegg and Watson, Calculus, Ninth Edition, Cengage Publishing Co., 2020 (as used in ESC194F). A Student Solution Manual for the text is also available. (Note that editions 5–8 of the Stewart text would be perfectly acceptable.)

Outline of the Course: The material covered in the course corresponds essentially to Chapters 7, 8, 10, 11, 13, 14 in the textbook. The following is a tentative timetable:

Review: 1 hr
Hyperbolic functions and l'Hospital's rule: 1 hr
Techniques of Integration, Chapter 7: 3 hrs
Applications of Integration, Chapter 8: 2 hrs
Parametric Equations, etc., Chapter 10: 4 hrs
Sequences and Series, Chapter 11: 10 hrs
Vector Functions, Chapter 13: 5 hrs
Partial Derivatives, Chapter 14: 8 hrs
Review: 2 hrs

Tentative Marking Scheme: The final mark will be based on 2 term tests (each counting for 15% of the final mark), the best 8 of 10 quizzes (together totalling 20%), and the final exam (50%). Each week there will be a 1-hour tutorial. Term tests are $1\frac{1}{2} - 2$ hours each and will be givn during the Tuesday morning test period. The quizzes will be given during the final 10-15 minutes of the tutorial sessions. The final examination is $2\frac{1}{2}$ hours, to be held during the examination period in April. It will be arranged by the Faculty of Applied Science and Engineering. There will be no aids (in particular, no calculators) allowed in any of the in-person quizzes, tests, or the final exam.

Midterm Tests: Thursday February 9, 9–11 (EX100)
Thursday March 30, 9–11 (EX100)

Quizzes: January 18, 25
February 1, 15
March 1, 8, 15, 22
April 5, 12

If you miss one of the midterm tests or more than two quizzes due to a documented conflict or unforeseen problem (e.g. physical or mental illness, injury, bereavement, etc.), please submit a Petition for Consideration in Course Work to your academic advisor in order to be considered for special accommodation

Approximate
Weekly Material Coverage

Week 1: January 9 – 13

Lecture 1 (January 9): Introduction
6.7 Hyperbolic Functions
Lecture 2 (January 12): 6.8 Indeterminate Forms and l'Hospital's Rule
Lecture 3 (January 13): Recap of Integration
7.1 Integration by Parts

Assigned problems:

6.7: 18, 21, 22, 51, 53, 59, 60
6.8: 24, 35, 41, 52, 53, 59, 60, 75, 99
7.1: 11, 13, 30, 33, 35, 39, 45, 54, 57, 59, 69, 75, 78, 81

Week 2: January 16 – 20

Lecture 4 (January 16): 7.2 Trigonometric Integrals
7.3 Trigonometric Substitution
Lecture 5 (January 19): 7.4 Partial Fractions
Lecture 6 (January 20): 7.8 Improper Integrals

Assigned problems:

7.2: 3, 11, 25, 31, 33, 39, 43, 45, 51, 65, 72, 77, 78
7.3: 15, 17, 19, 26, 29, 31, 35, 37, 45, 49
7.4: 9, 17, 23, 25, 35, 37, 39, 41, 47, 51, 63, 65, 67, 72
7.5: 12, 31, 39, 41, 49, 55, 57, 63, 65, 71, 75, 81, 85
7.8: 9, 23, 29, 37, 39, 45, 47, 63, 67, 72, 77, 80, 85, 91

Quiz #1 (January 18) – Sections 6.7 – 7.1

Week 3: January 23 – 26

Lecture 7 (January 23): 8.1 Arc Length
8.2 Area of a Surface of Revolution
Lecture 8 (January 26): 8.3 Applications to Physics and Engineering

Assigned problems:

8.1: 11, 13, 17, 23, 39, 43, 47, 51
8.2: 13, 15, 19, 33, 35, 37
8.3: 7, 14, 15, 31, 37, 41, 45

Quiz #2 (January 25) – Sections 7.2 – 7.8

Week 4: January 30 to February 3

Lecture 9 (January 30): 10.1 Curves Defined by Parametric Equations
10.2 Calculus with Parametric Curves
Lecture 10 (February 2): 10.3 Polar Coordinates
Lecture 11 (February 3): 10.4 Areas and Lengths in Polar Coordinates

Assigned problems:

10.1: 11, 15, 19, 27, 34, 37, 41, 47, 51, 53, 56
10.2: 7, 9, 19, 21, 29, 33, 35, 47, 51, 55, 71, 75, 79, 80, 85
10.3: 3, 5, 13, 19, 25, 33, 37, 45, 48, 53, 57, 61
10.4: 7, 11, 17, 21, 27, 33, 41, 49, 51, 67, 71, 75

Quiz #3 (February 1) – Sections 8.1 – 8.3

Week 5: February 6 – 10

Lecture 12 (February 6): 11.1 Sequences Part 1
Lecture 13 (February 9): 11.1 Sequences Part 2
Lecture 14 (February 10): 11.2 Series

Assigned problems:

11.1: 7, 21, 29, 47, 48, 53, 61, 75, 79, 86, 87, 96
11.2: 23, 29, 45, 47, 59, 61, 69, 76, 83, 85, 91, 93

Show directly by long division that $\frac{1}{1-x} = \sum_{n=0}^{\infty} x^n$

No quiz – tutorials on February 8 devoted to test review

Midterm Test #1 (February 9) – All material from lectures 1-11 (Sections 6.7 – 10.4)

Week 6: February 13 – 17

Lecture 15 (February 13): 11.3 The Integral Test and Estimates of Sums
11.4 The comparison Tests
Lecture 16 (February 16): 11.5 Alternating Series and Absolute Convergence
11.6 The Ratio and Root Tests
Lecture 17 (February 17): 11.8 Power Series
11.9 Representations of Functions as Power Series

Assigned problems:

11.3: 5, 17, 23, 27, 31, 33, 37, 41, 47
11.4: 11, 15, 23, 33, 41, 53, 54
11.5: 11, 15, 19, 31, 43, 47, 50, 53
11.6: 5, 9, 13, 17, 31, 35, 41, 42, 46
11.7: 23, 35, 37, 41, 43, 45, 47
11.8: 11, 19, 25, 33, 37, 43
11.9: 7, 13, 21, 29, 31, 43, 45

Quiz #4 (February 15) – Sections 11.1 – 11.2

Week 7: February 27 to March 3

Lecture 18 (February 27): 11.10 Taylor and Maclaurin Series Part 1
Lecture 19 (March 2): 11.10 Taylor and Maclaurin Series Part 2
Lecture 20 (March 3): 11.11 Applications of Taylor Polynomials
11.12 The Binomial Series

Assigned problems:

11.10: 11, 19, 23, 47, 55, 61, 71, 73, 87, 96, 97
11.11: 5, 17, 23, 25, 33, 35
11.12: Binomial Series

1) Stewart 11.10: 35, 37, 57
2) (a) Expand $f(x) = x/(1-x)^2$ as a power series.

(b) Use part (a) to find the sum of the series $\sum_{n=1}^{\infty} \frac{n}{2^n}$

Quiz #5 (March 1) – Sections 11.3 – 11.9

Week 8: March 6 – 10

Lecture 21 (March 6) 11.13 Fourier Series
12.5 Equations of Lines and Planes
Lecture 22 (March 9): 12.6 Cylinders and Quadric Surfaces
13.1 Vector Functions and Space Curves
Lecture 23 (March 10): 13.2 Derivatives and Integrals of Vector Functions

Assigned problems:

11.13: Fourier Series: 1, 5, 9, 19 (from Stewart supplement)
12.5: (1, 9, 19, 25, 35, 45, 51, 59, 65, 73, 77)
12.6: 15, 19, 21, 23–30, 37
13.1: 3, 15, 16, 25–30, 35, 51, 61
13.2: 5, 13, 19, 23, 27, 37, 43, 47

Quiz #6 (March 8) – Sections 11.10 – 11.12

Week 9: March 13 – 17

Lecture 24 (March 13): 13.3 Arc Length and Curvature
Lecture 25 (March 16): 13.4 Motion in Space: Velocity and Acceleration
Lecture 26 (March 17): Charged Particle Motions in Electric and Magnetic Fields

Assigned problems:

13.3: 5, 15, 23, 27, 35, 39, 46, 53, 65, (71, 72)
13.4: 5, 13, 19, 37, 41, 45, 46

Quiz #7 (March 15) – Sections 11.13 – 13.2

Week 10: March 20 – 24

Lecture 27 (March 20): 14.1 Functions of Several Variables
14.2 Limits and Continuity
Lecture 28 (March 23): 14.3 Partial Derivatives
Lecture 29 (March 24): 14.4 & 14.6 Directional Derivatives and the Gradient Vector Part 1

Assigned problems:

14.1: 3, 15, 29, 49, 61–66, 69
14.2: 21, 23, 27, 29, 37, 49
14.3: 19, 23, 41, 51, 61, 77, 79, 81, 84, 93, 97

Quiz #8 (March 22) – Sections 13.3 – 13.4

Week 11: March 27 – 31

Lecture 30 (March 27): 14.4 & 14.6 Directional Derivatives and the Gradient Vector Part 2
14.5 The Chain Rule
Lecture 31 (March 30): 14.6 & 14.4 Tangent Planes and Linear Approximations
Lecture 32 (March 31): 14.7 Maximum and Minimum Values Part 1

Assigned problems:

14.4: 5, 9, 21, 27, 43, 53
14.5: 7, 15, 23, 27, 33, 39, 45, 49, 51
14.6: 5, 13, 19, 25, 29, 41, 51, 55, 59, 67, 69

Use the formal definition for the derivative of a multi-variable function (the $o(h)$ formulation) to find the gradient of the following functions. Show that all remainder terms are $o(h)$.

i) $f(x, y) = xy$
ii) $f(x, y) = 3x^2 - xy + y$
iii) $f(x, y, z) = x^2y + y^2z + z^2x$

No quiz – tutorials on March 29 devoted to test review

Midterm Test #2 (March 30) – All material from lectures 12-26 (Sections 11.1 – 14.3)

Week 12: April 3 – 6

Lecture 33 (April 3): 14.7 Maximum and Minimum Values Part 2
Lecture 34 (April 6): 14.8 Lagrange Multipliers
14.9 Reconstructing a Function from its Gradient

Assigned problems:

14.7: 13, 19, 27, 37, 41, 45, 51, 53, 61
14.8: 5, 9, 29, 33, 43, 49, 51, 57, (Applied Project: Rocket Science)
14.9: Reconstructing a Function from its Gradient
1) Determine whether the vector function is a gradient $\nabla f(x, y)$ and, if so, find such a function f.

i) $(y^3 + x)\hat{i} + (x^2 + y)\hat{j}$
ii) $(1 + e^y)\hat{i} + (xe^y + y^2)\hat{j}$
iii) $(y \sin x + xy \cos x)\hat{i} + (x \sin x + 2y + 1)\hat{j}$

2) Determine whether the vector function is a gradient $\nabla f(x, y, z)$ and, if so, find such a function f.
i) $yz\,\hat{i} + xz\,\hat{j} + xy\,\hat{k}$
ii) $\left[\frac{y}{z} - e^z\right]\hat{i} + \left[\frac{x}{z} + 1\right]\hat{j} - \left[xe^z + \frac{xy}{z^2}\right]\hat{k}$

Quiz #9 (April 5) – Sections 14.4 – 14.6

Week 13: April 10 – 14

Lecture 35 (April 10): Rocket Science
Lecture 36 (April 13): 14.10 Differentiability of an Integral wrt its Parameter
Lecture 37 (April 14): Review

Assigned problems:

14.10: Differentiability of an Integral with respect to its Parameter:

1) Find the derivatives, $dF(x)/dx$, for the following functions in two ways: (a) integrating first and (b) differentiating first:
i) $F(x) = \int_0^3 \left(xy^3 - \frac{y}{x}\right)\,dy$
ii) $F(x) = \int_{\pi/3}^{\pi/2} \sin y\, cosx\, dy$
iii) $F(x) = \int_a^b e^x \ln(xy)\,dy$

2) Find the derivatives, $dF(t)/dt$, for the following functions:
i) $F(t) = \int_0^1 y^2\,dy$
ii) $F(t) = \int_0^{e^t} \ln y\,dy$
iii) $F(t) = \int_t^{t^2} \tan^{-1}(e^y)\,dy$

3) Find the derivatives, $dF(x)/dx$, for the following functions:
i) $F(x) = \int_0^x x^2 y\,dy$
ii) $F(x) = \int_0^{x^2} \frac{y - x}{y + x}\,dy$

4) Solve the following integral equations; that is, find the functions $f(x)$ which satisfy the following relationships:
i) $f(x) = a - \int_b^x (x - t)f(t)\,dt$
ii) $f(x) = x + \int_0^x (x - 2t)f(t)\,dt$

5) Evaluate $\displaystyle\int_0^x \frac{dt}{(x^2+t^2)}$ and use the result to help you evaluate:
$\displaystyle\int_0^x \frac{dt}{(x^2+t^2)^2}$ and $\displaystyle\int_0^x \frac{dt}{(x^2+t^2)^3}$

6) a) Given that $\displaystyle\int_0^\infty e^{-xt}\sin t\,dt = \frac{1}{1+x^2}$ for $x>0$ (which can be shown by integration by parts), evaluate: $\displaystyle\int_0^\infty te^{-xt}\sin t\,dt$ and $\displaystyle\int_0^\infty t^2e^{-xt}\sin t\,dt$

b) Referring to part a), for $x>0$ evaluate: $F(x) = \displaystyle\int_0^\infty e^{-xt}\frac{\sin t}{t}\,dt$

Use this result to evaluate the integral: $\displaystyle\int_0^\infty \frac{\sin t}{t}\,dt$

Quiz #10 (April 12) – Sections 14.7 – 14.9