

Technical Calculus II

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1 Course Description

Course: 2030:356 Technical Calculus II

Credits: 3

Prerequisites: 2030:255 or equivalent with a grade of C– or better, or placement test.

Bulletin Description: Prerequisites: 2030:255 or equivalent with a grade of C– or better, or placement test. Methods and applications of integration, first and second order differential equations, series expansion, Laplace transforms, partial derivatives, and double integrals.

2 Course Outcomes

After completing this course the student should have the following competencies:

1. the ability to find the integral of a function by using partial fractions, integration by parts, or trigonometric substitution;
2. the ability to find areas and volumes by integration;
3. the ability to find the solutions of first-order differential equations using separation of variables or integrating factors;
4. the ability to solve second-order differential equations using standard methods and Laplace transforms;
5. the ability to use differential equations when solving real-world problems;
6. an understanding of the properties of numerical series and series of functions.

3 Course Outline

1. Applications of integration

- (a) Area between curves
- (b) Volumes of revolution—disk method
- (c) Volumes of revolution—shell method
- (d) Center of mass
- 2. Methods of integration
 - (a) Partial fractions
 - (b) Integration by parts
 - (c) Trigonometric substitution
 - (d) Integration using tables
 - (e) Numerical methods
- 3. First-order differential equations
 - (a) Solutions of differential equations
 - (b) Separation of variables
 - (c) Integrating factors
 - (d) First-order linear equations
 - (e) Applications
- 4. Second-order differential equations
 - (a) Linear homogeneous case
 - (b) Linear nonhomogeneous case
 - (c) Applications
 - (d) Laplace transforms
 - (e) Using Laplace transforms to solve differential equations
- 5. Series
 - (a) Convergence
 - (b) Convergence tests
 - (c) Power series
 - (d) Maclaurin and Taylor series
 - (e) Approximating series
 - (f) Fourier series

4 Textbook

Technical Calculus with Analytic Geometry. Peter Kuhfittig. Brooks/Cole, Cengage Learning, Fifth Edition, 2013.

Chapter 4: 4.6, 4.7, 4.9

Chapter 5: 5.2, 5.3, 5.4, 5.5 (optional), 5.6 (optional)

Chapter 7: 7.6, 7.7, 7.8, 7.9

Chapter 11: 11.1, 11.2, 11.3, 11.4

Note: Use supplemental material to cover exact differentials.

Chapter 12: 12.1, 12.2, 12.3, 12.4

Chapter 13: 13.1, 13.2, 13.3, 13.4

Chapter 10: 10.1, 10.2, 10.3, 10.4, 10.5, 10.6

Note: There may not be enough time to cover chapter 10. If there is time, the most important sections are 10.3 and 10.6.

5 Calculator Policy

All students are **required** to have a **graphing** calculator with minimum functionality equivalent to that of the **Texas Instruments TI-83** calculator. Every student is **required** to have possession of their calculator by the end of the first week of classes. No exceptions to this policy will be made by the instructor.

6 Formula Policy

The formulas that students are required to know by heart at the beginning of this course are listed below.

Factoring Formulas

$$a^2 - b^2 = (a - b)(a + b)$$

$$x^2 + (a + b)x + ab = (x + a)(x + b)$$

$$acx^2 + (ad + bc)x + bd = (ax + b)(cx + d)$$

Quadratic Formula

Let $ax^2 + bx + c = 0$ where a , b , and c are constants with $a \neq 0$.

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Equations of Lines

Assume a line passes through (x_1, y_1) and (x_2, y_2) with slope m and y -intercept b .

$$m = \frac{y_2 - y_1}{x_2 - x_1} \quad y - y_1 = m(x - x_1) \quad y = mx + b$$

Distance Formula

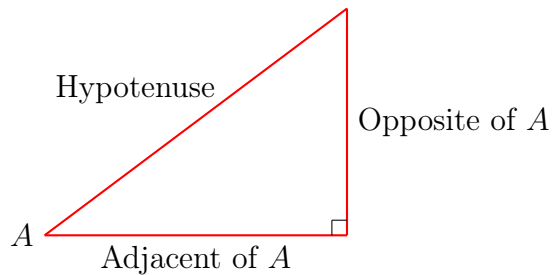
Let d be the distance between (x_1, y_1) and (x_2, y_2) .

$$d = \sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}$$

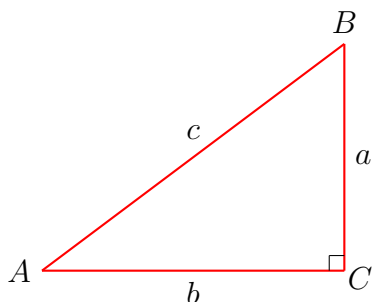
Parallel and Perpendicular Lines

Suppose two lines have slopes m_1 and m_2 respectively. If the lines are parallel, then $m_1 = m_2$. If the lines are perpendicular, then $m_2 = -1/m_1$.

Right Triangle Trigonometry



$$\begin{array}{lll} \sin(A) = \frac{\text{Opposite of } A}{\text{Hypotenuse}} & \cos(A) = \frac{\text{Adjacent of } A}{\text{Hypotenuse}} & \tan(A) = \frac{\text{Opposite of } A}{\text{Adjacent of } A} \\ \csc(A) = \frac{\text{Hypotenuse}}{\text{Opposite of } A} & \sec(A) = \frac{\text{Hypotenuse}}{\text{Adjacent of } A} & \cot(A) = \frac{\text{Adjacent of } A}{\text{Opposite of } A} \end{array}$$



$$a^2 + b^2 = c^2 \quad A + B = 90^\circ$$

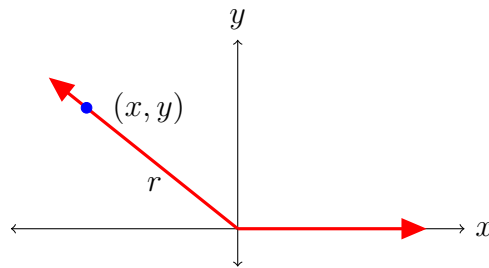
$$\begin{array}{lll} \sin(A) = a/c & \cos(A) = b/c & \tan(A) = a/b \\ \csc(A) = c/a & \sec(A) = c/b & \cot(A) = b/a \\ \sin(B) = b/c & \cos(B) = a/c & \tan(B) = b/a \\ \csc(B) = c/b & \sec(B) = c/a & \cot(B) = a/b \end{array}$$

$$A = \sin^{-1}(a/c) = \cos^{-1}(b/c) = \tan^{-1}(a/b)$$

$$B = \sin^{-1}(b/c) = \cos^{-1}(a/c) = \tan^{-1}(b/a)$$

General Trigonometry

Angle θ is shown below in standard position. The initial side of θ is the positive x -axis, and the vertex of θ is the origin $((0, 0))$. Point (x, y) is a point on the terminal side of θ , and r is the distance from $(0, 0)$ to (x, y) .



$$r^2 = x^2 + y^2$$

$$\sin(\theta) = y/r$$

$$\cos(\theta) = x/r$$

$$\tan(\theta) = y/x$$

$$\csc(\theta) = r/y$$

$$\sec(\theta) = r/x$$

$$\cot(\theta) = x/y$$

Radian Measure

$$180^\circ = \pi \text{ radians}$$

Let θ be the radian measure of a central angle of a circle with radius r . Let s be the length of the circular arc intercepted by θ , and A the area of the circular sector made by θ .

$$s = r\theta \quad A = \frac{1}{2}r^2\theta$$

Factoring Formulas

$$a^3 - b^3 = (a - b)(a^2 + ab + b^2)$$

$$a^3 + b^3 = (a + b)(a^2 - ab + b^2)$$

Product Formulas

$$(a \pm b)^2 = a^2 \pm 2ab + b^2$$

$$(a \pm b)^3 = a^3 \pm 3a^2b + 3ab^2 \pm b^3$$

Exponents

$$a^{-n} = \frac{1}{a^n}$$

$$a^{m/n} = (\sqrt[n]{a})^m = \sqrt[n]{a^m}$$

Logarithms

$$\log_b(mn) = \log_b(m) + \log_b(n) \quad (m > 0, n > 0)$$

$$\log_b\left(\frac{m}{n}\right) = \log_b(m) - \log_b(n) \quad (m > 0, n > 0)$$

$$\log_b(m^n) = n \log_b(m) \quad (m > 0) \quad \log_b(b) = 1 \quad \log_b(1) = 0$$

$$\log(m) = \log_{10}(m) \quad \ln(m) = \log_e(m) \quad \log_b(m) = \frac{\log_a(m)}{\log_a(b)}$$

Fundamental Trigonometric Identities

$$\csc(x) = \frac{1}{\sin(x)} \quad \sec(x) = \frac{1}{\cos(x)} \quad \cot(x) = \frac{1}{\tan(x)}$$

$$\tan(x) = \frac{\sin(x)}{\cos(x)} \quad \cot(x) = \frac{\cos(x)}{\sin(x)}$$

$$\sin^2(x) + \cos^2(x) = 1 \quad \sin(2x) = 2 \sin(x) \cos(x)$$

$$\sin^2(x) = \frac{1 - \cos(2x)}{2} \quad \cos^2(x) = \frac{1 + \cos(2x)}{2}$$

Differentiation and Integration Formulas

$$\frac{d}{dx}(u^n) = n u^{n-1} \frac{du}{dx}$$

$$\frac{d}{dx}(uv) = u \frac{dv}{dx} + v \frac{du}{dx}$$

$$\frac{d}{dx}\left(\frac{u}{v}\right) = \frac{v \frac{du}{dx} - u \frac{dv}{dx}}{v^2}$$

$$\frac{d}{dx}(\sin(u)) = \cos(u) \frac{du}{dx}$$

$$\frac{d}{dx}(\cos(u)) = -\sin(u) \frac{du}{dx}$$

$$\frac{d}{dx}(\tan(u)) = \sec^2(u) \frac{du}{dx}$$

$$\frac{d}{dx}(\sec(u)) = \sec(u) \tan(u) \frac{du}{dx}$$

$$\frac{d}{dx}(\csc(u)) = -\csc(u) \cot(u) \frac{du}{dx}$$

$$\frac{d}{dx}(\cot(u)) = -\csc^2(u) \frac{du}{dx}$$

$$\frac{d}{dx}(\sin^{-1}(u)) = \frac{1}{\sqrt{1-u^2}} \frac{du}{dx}$$

$$\frac{d}{dx}(\cos^{-1}(u)) = -\frac{1}{\sqrt{1-u^2}} \frac{du}{dx}$$

$$\frac{d}{dx}(\tan^{-1}(u)) = \frac{1}{1+u^2} \frac{du}{dx}$$

$$\frac{d}{dx}(\ln(u)) = \frac{1}{u} \frac{du}{dx}$$

$$\frac{d}{dx}(e^u) = e^u \frac{du}{dx}$$

$$\int u^n du = \frac{u^{n+1}}{n+1} + C \quad (n \neq -1)$$

$$\int \frac{1}{u} du = \ln |u| + C$$

$$\int e^u du = e^u + C$$

$$\int \sin(u) du = -\cos(u) + C$$

$$\int \cos(u) du = \sin(u) + C$$

$$\int \sec^2(u) du = \tan(u) + C$$

$$\int \csc^2(u) du = -\cot(u) + C$$

$$\int \sec(u) \tan(u) du = \sec(u) + C$$

$$\int \csc(u) \cot(u) du = -\csc(u) + C$$

$$\int \tan(u) du = -\ln |\cos(u)| + C$$

$$\int \cot(u) du = \ln |\sin(u)| + C$$

$$\int \sec(u) du = \ln |\sec(u) + \tan(u)| + C$$

$$\int \csc(u) du = \ln |\csc(u) - \cot(u)| + C$$