Module (Course Syllabus) Catalogue

2023 - 2024

College/ Institute	Erbil Technology College	
Department	Construction and Materials Technology Engineering department	
Module Name	Calculus II	
Module Code	CAL123	
Degree	Technical Diploma ☒ Bachelor ☐ High Diploma ☐ Master ☐ PhD ☐	
Semester	Second	
Qualification		
Scientific Title	Assist Lecturer	
ECTS (Credits)	7	
Module type	Prerequisite ☐ Core ☐ Assist. ☒	
Weekly hours	5	
Weekly hours (Theory)	(5)hr Class	(189)Total hrs Workload
Weekly hours (Practical)	( )hr Class	( ) Total hrs Workload
Number of Weeks	12	
Lecturer (Theory)	Lawin Dhahir Hayder	
E-Mail & Mobile NO.	Lawin.hayder@epu.edu.iq	
Lecturer (Practical)		
E-Mail & Mobile NO.		
Websites		

Course Book

Course Description	This course is one of the main courses for 1st stage students in construction materials and technology departments and aims to introduce the engineering mathematics for the students. To learn Integration, The definite integral and the Fundamental Theorem of Calculus, Indefinite Integrals and the Substitution Method, The Logarithm Defined as an Integral, Integrals of exponential function, Trigonometric Integrals, Trigonometric Substitutions, Integration by Parts, Integration of Rational Functions by Partial Fractions, Numerical Integration. Substitution and Area Between Curves, Volumes Using Cross-Sections, Volumes Using Cylindrical Shells and Arc Length, Trapezoidal Rule and Simpson's Rule.
Course objectives	To introduce the concept of integration, study various techniques of integration and illustrate some applications of integration. 1. Learn the general form of integration. 2. Learn to work with exponential, logarithmic and trigonometric functions and their applications in applied problems. 3. Learn the concepts of the anti- derivative and its underlying concepts such as limits and continuity. 4. Learn to calculate anti- derivative for various type of functions using definition and rules. 5. Apply the concept of anti - derivative to completely analyze graph of a function. 6. Learn about various applications of the anti-derivative in applied problems.

<table>
<tr><td></td><td colspan="5">7. Learn about anti-derivative and the Fundamental Theorem of Calculus and its applications.
8. Learn to use concept of integration to evaluate geometric area and solve other applied problems</td></tr>
<tr><td>Student's obligation</td><td colspan="5">Attending the lecture is a fundamental part of the course. You are responsible for material presented in the lecture whether or not it is discussed in the textbook. You should expect questions on the exams to test your understanding of concepts discussed in the lecture and in the homework assignments.
It can be very helpful to study with a group. This type of cooperative learning is encouraged; however, be sure that you have a thorough understanding of the concepts besides the mathematical steps used to solve a problem. You must be able to work through the problems on your own.</td></tr>
<tr><td>Required Learning Materials</td><td colspan="5">Data Show, Handout lecture notes and white board notes.</td></tr>
<tr><td rowspan="10">Evaluation</td><td colspan="2">Task</td><td>Weight (Marks)</td><td>Due Week</td><td>Relevant Learning Outcome</td></tr>
<tr><td colspan="2">Paper Review</td><td></td><td></td><td></td></tr>
<tr><td rowspan="6">Assignments</td><td>Homework</td><td>10%</td><td></td><td></td></tr>
<tr><td>Class Activity</td><td>2%</td><td></td><td></td></tr>
<tr><td>Report</td><td></td><td></td><td></td></tr>
<tr><td>Seminar</td><td>8%</td><td></td><td></td></tr>
<tr><td>Essay</td><td></td><td></td><td></td></tr>
<tr><td>Project</td><td>8%</td><td></td><td></td></tr>
<tr><td colspan="2">Quiz</td><td>8%</td><td></td><td></td></tr>
<tr><td colspan="2">Lab.</td><td></td><td></td><td></td></tr>
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<tr><td rowspan="3"></td><td>Midterm Exam</td><td>24%</td><td></td><td></td></tr>
<tr><td>Final Exam</td><td>40%</td><td></td><td></td></tr>
<tr><td>Total</td><td>100%</td><td></td><td></td></tr>
<tr><td>Specific learning outcome:</td><td colspan="4">Upon completion of the course, the student will be able to:

1. Find the anti-derivative of elementary polynomials, exponential, logarithmic and trigonometric functions.

2. Use the Fundamental Theorem of Calculus to evaluate definite integrals.

3. Definite integrals to find areas of planar regions.

4. Interpret the definite integral geometrically as the area under a curve.

5. Construct a definite integral as the limit of a Riemann sum.

6. Approximate a definite integral using left sum, right sum, midpoint and trapezoidal rules.

7. Interpret the indefinite integral as a definite integral with variable limit(s).

8. Interpret differentiation and anti-differentiation as inverse operations (Fundamental Theorem of Calculus, part 1).

9. Interpret the anti-derivative as a definite integral with variable limit and implement this expression on graphing platforms.

10. Evaluate a definite integral using an anti-derivative (Fundamental Theorem of Calculus, part 2).

11. Use substitution to find the anti-derivative of a composite function.

12. Apply basic optimization techniques to selected problems arising in various fields such as physical modelling, economics and population dynamics.</td></tr>
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	13. Interpret a volume of revolution of a function's graph around a given axis as a (Riemann) sum of disks or cylindrical shells, convert to definite integral form and compute its value. 14. Express the length of a curve as a (Riemann) sum of linear segments, convert to definite integral form and compute its value. 15. Express the surface area of revolution of a function's graph around a given axis as a (Riemann) sum of rings, convert to definite integral form and compute its value. 16. Anti-differentiate products of functions by parts. 17. Recognize and implement appropriate techniques to anti-differentiate products of trigonometric functions. 18. Devise and apply a trigonometric substitution in integrals involving Pythagorean quotients. 19. Decompose a rational integrand using partial fractions. 20. Express the length of a curve as a (Riemann) sum of linear segments, convert to definite integral form and compute its value. 21. Evaluate integrals by different methods of integration. 22. Understand the concept of indefinite integral as anti-derivative.
Course References:	1. Stewart, J. (2016). *Single variable calculus: Early transcendentals* (Eight edition.). Boston, MA, USA: Cengage Learning. (Major). 2. Lecture Notes. (Minor)

Course topics (Theory)	**Week**	**Learning Outcome**

Integration, Indefinite Integrals and definite integrals.	1	
Integration of Trigonometric Function and Exponential Function	2	
Substitution Rule	3	
Integration by Parts	4	
Integration of Rational Functions by Partial Fractions	5	
Mid Term Exam	6	
Numerical Integration: Trapezoidal Rule and Simpson's Rule.	7 & 8	
Area, Area Between Curves and Average Value of a Continuous Function Revisited	9 & 10	
Volume, Volume of Pyramid, Volume of a Wedge, A Solid of Revolution, Volume of Sphere,	11 & 12	
Final Exam	13 & 14	

Questions Example Design

Q1:

Find $\int \cos(7\theta + 3)\, d\theta$.

Solution:

$$\begin{aligned}\int \cos(7\theta + 3)\, d\theta &= \frac{1}{7}\int \cos(7\theta + 3)\cdot 7\, d\theta \\ &= \frac{1}{7}\int \cos u\, du \\ &= \frac{1}{7}\sin u + C \\ &= \frac{1}{7}\sin(7\theta + 3) + C\end{aligned}$$

Q2:

Use partial fractions to evaluate

$$\int \frac{dx}{x(x^2+1)^2}.$$

Solution The form of the partial fraction decomposition is

$$\frac{1}{x(x^2+1)^2} = \frac{A}{x} + \frac{Bx+C}{x^2+1} + \frac{Dx+E}{(x^2+1)^2}$$

Multiplying by $x(x^2+1)^2$, we have

$$\begin{aligned}1 &= A(x^2+1)^2 + (Bx+C)x(x^2+1) + (Dx+E)x \\ &= A(x^4+2x^2+1) + B(x^4+x^2) + C(x^3+x) + Dx^2 + Ex \\ &= (A+B)x^4 + Cx^3 + (2A+B+D)x^2 + (C+E)x + A\end{aligned}$$

If we equate coefficients, we get the system

$$A+B=0, \quad C=0, \quad 2A+B+D=0, \quad C+E=0, \quad A=1.$$

Solving this system gives $A=1$, $B=-1$, $C=0$, $D=-1$, and $E=0$. Thus,

$$\begin{aligned}\int \frac{dx}{x(x^2+1)^2} &= \int \left[\frac{1}{x} + \frac{-x}{x^2+1} + \frac{-x}{(x^2+1)^2}\right] dx \\ &= \int \frac{dx}{x} - \int \frac{x\,dx}{x^2+1} - \int \frac{x\,dx}{(x^2+1)^2} \\ &= \int \frac{dx}{x} - \frac{1}{2}\int \frac{du}{u} - \frac{1}{2}\int \frac{du}{u^2} \qquad u = x^2+1,\ du = 2x\,dx \\ &= \ln|x| - \frac{1}{2}\ln|u| + \frac{1}{2u} + K \\ &= \ln|x| - \frac{1}{2}\ln(x^2+1) + \frac{1}{2(x^2+1)} + K \\ &= \ln\frac{|x|}{\sqrt{x^2+1}} + \frac{1}{2(x^2+1)} + K.\end{aligned}$$

Q3:Find the integrals of the following:

1. $\displaystyle\int_1^4 \left(\frac{3}{2}\sqrt{x} - \frac{4}{x^2}\right) dx$
2. $\displaystyle\int x\cos x\,dx.$

Solution: 1)

$$\begin{aligned}\int_1^4 \left(\frac{3}{2}\sqrt{x} - \frac{4}{x^2}\right) dx &= \left[x^{3/2} + \frac{4}{x}\right]_1^4 \qquad \frac{d}{dx}\left(x^{3/2}+\frac{4}{x}\right) = \frac{3}{2}x^{1/2} - \frac{4}{x^2} \\ &= \left[(4)^{3/2} + \frac{4}{4}\right] - \left[(1)^{3/2} + \frac{4}{1}\right] \\ &= [8+1] - [5] = 4\end{aligned}$$

2)

Solution We use the formula $\int u\,dv = uv - \int v\,du$ with

$$u = x, \qquad dv = \cos x\,dx,$$
$$du = dx, \qquad v = \sin x. \qquad \text{Simplest antiderivative of } \cos x$$

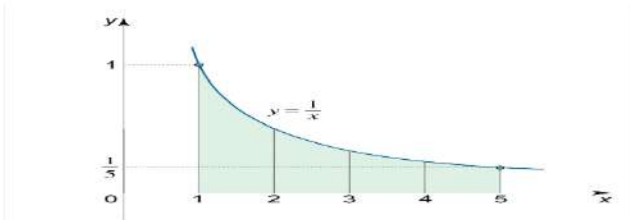
Then

$$\int x\cos x\,dx = x\sin x - \int \sin x\,dx = x\sin x + \cos x + C.$$

Q4:

Approximate the area under the curve $y = \frac{1}{x}$ between $x = 1$ and $x = 5$ using the Trapezoidal Rule with $n = 4$ subintervals.

Solution.



We write the Trapezoidal Rule formula for $n = 4$ subintervals:

$$T_4 = \frac{\Delta x}{2}\left[f(x_0) + 2f(x_1) + 2f(x_2) + 2f(x_3) + f(x_4)\right].$$

The function has the following values at the points x_i :

$$f(x_0) = f(1) = \frac{1}{1} = 1;$$

$$f(x_1) = f(2) = \frac{1}{2};$$

$$f(x_2) = f(3) = \frac{1}{3};$$

$$f(x_3) = f(4) = \frac{1}{4};$$

$$f(x_4) = f(5) = \frac{1}{5}.$$

$$f(x_4) = f(5) = \frac{1}{5}.$$

Since $\Delta x = 1$, we obtain

$$A \approx T_4 = \frac{1}{2}\left[1 + 2\cdot\frac{1}{2} + 2\cdot\frac{1}{3} + 2\cdot\frac{1}{4} + \frac{1}{5}\right] = \frac{1}{2}\left[1 + 1 + \frac{2}{3} + \frac{1}{2} + \frac{1}{5}\right]$$
$$= \frac{1}{2}\cdot\frac{30 + 30 + 20 + 15 + 8}{30} = \frac{1}{2}\cdot\frac{101}{30} = \frac{101}{60}$$

Extra notes:

External Evaluator

Approved

Dr. Saad Khalis Essa