Department of Mathematics
Engineering Mathematics II | Course outline

Course code and name: 0301101, Engineering Mathematics II
Credit hours: 3
Prerequisite: Engineering Mathematics I
Teaching Language: English

Instructor Name	Dr. Baha Alzalg
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Course Description

Vector differential calculus, line and surface integrals, integral theorems, Fourier series, Fourier integrals, Fourier transforms, partial differential equations.

Learning Objectives

In this course, we teach three essential topics for engineering students. These topics are Advanced Calculus, Fourier Series and Fourier Integrals, and Partial Differential Equations. In chapter 9, we will review Vector Product, Curves: Circle, Ellipse, Straight Line, Helix, Plane Curves, Tangent to a Curve, and Gradient of a Scalar Field. Then we will cover the Divergence and Curl of a Vector Field. Also, we will talk about the importance of the Divergence and Curl of a Vector Field. In chapter 10, we start with the line integral of a vector field. The computation of the line integral over various types of paths will be given. Also, examples that show that line integral is path dependent is given. In case the line integral is path independent, the vector field is called conservative. It turns out that vector fields that are conservative are the ones that are a gradient of a scaler field. Students will be exposed to this material and investigate several examples that enhance their understanding. Also, students learn that a vector field is conservative if and only if its curl is equal to zero. One of the main tools in computing line integrals is Green's Theorem. Green's Theorem will be presented along with various examples that explain the importance of this theorem and how to apply it. Students study surfaces. They will look at two ways to represent surfaces. Important types of surfaces (such as: Planes, Cylinders, Paraboloid, Cones, an Spheres) will be presented. The study of surfaces is essential in computing surface integrals. Evaluating surface integrals (flux) over various types of surfaces will be given. One of the celebrated theorems in advanced calculus is the Divergence Theorem of Gauss. Student learn how to utilize the Divergence Theorem in computing the flux through a surface by computing the triple integral of the divergence of the vector field over the solid inside that surface. Student will see through examples that the use of the Divergence Theorem is a very powerful tool to evaluate the flux. Another famous theorem to compute the line integral in space is Stokes's Theorem. This Theorem is a generalization of Green's Theorem to space. Students learn how to apply this theorem to compute some of the line integrals in space.

The second topic of this course is Fourier Series and Fourier Integrals. This topic is given in chapter 11 of the book. The set of functions 1, cos(nx) and sin(nx) where n is a positive integer are orthogonal periodic functions. Students learn how to write a general periodic function in terms of these simple periodic functions. This will lead them to Fourier Series which is an infinite series of sines and cosines. Also, students learn about the convergence of this series. Fourier Series plays a very important role in solving Partial Differential Equations (such as wave equation, heat equation, and Laplace equation). For nonperiodic functions that are defined on R or R^+, students will learn how to find Fourier integrals and Fourier Sine and Cosine integrals. Also, students learn how to evaluate Fourier Transform, Fourier Sine Transform and Fourier Cosine Transform.
The last topic of this course is Partial Differential Equations (PDEs). PDEs play an important role in modeling many real life problems. PDEs are very important in dynamics, elasticity, heat transfer, electromagnetic theory, and quantum mechanics. They have a much wider range of applications than ODEs, which can model only the simplest physical systems. The most important PDEs are the wave equation that can model the vibrating string and the vibrating membrane, the heat equation for temperature in a bar or wire, and the Laplace equation for electrostatic potentials in both cartesian and polar coordinates. Students learn how to derive the PDE that models the phenomena, such as the one-dimensional wave equation for a vibrating elastic string and the heat equation in a bar of length L. A very powerful technique of solving such PDEs is the separation of variables method. Students apply the separation of variables method to solve wave and heat equations in a finite string. Also, they use this method to solve Laplace equation over both a bounded plate and a disk. Students learn how to use Fourier Transform, Fourier Sine Transform and Fourier Cosine Transform to solve wave equation, heat equation, and Laplace equation over an infinite domain or a semi-infinite domain.

Intended Learning Outcomes (ILOs):

Successful completion of the course should lead to the following outcomes:

A. Knowledge and Understanding Skills: Student is expected to

A1. Evaluating and applying the gradient of a scalar function and the divergence and curl of a vector field.

A2. Evaluating line integrals and applying the path independence and exactness theorems.

B. Intellectual Analytical and Cognitive Skills: Student is expected to

B1. Understanding Green's theorem in plane (Transformation between double and line integrals) and applying it to evaluate double and line integrals.

B2. Understanding the divergence theorem of Gauss (Transformation between triple and surface integrals) and Stokes theorem (transformation between surface and line integrals) and applying them to evaluate related integrals.

C. Subject- Specific Skills: Student is expected to

C1. Constructing the Fourier series and Fourier Sine and Cosine series to represent general periodic functions in terms of simple ones, namely, Cosines and Sines.
C2. Constructing the Fourier, Fourier Cosine, and Fourier Sine integrals and transforms of non-periodic functions.
C3. Using the Fourier series, integrals, and transforms, to solve different types of partial differential equations (Heat, Wave, Laplace, …).

D. Creativity /Transferable Key Skills/Evaluation: Student is expected to

D1. Use the partial differential equations in various branches of mathematics, physics and engineering.

ILOs: Learning and Evaluation Methods

ILO/s	Learning Methods	Evaluation Methods	Related ILO/s to the program
	Lectures	**Exam**	**A1**

Course Contents

Content	Reference	Week	ILO/s	Evaluation Methods
Chapter 9: Vector Differential Calculus. Grad, Div, Curl. 9.3 Vector Product (Review). Suggested problems: 2, 11-23, 28-31 9.5 Curves: Circle, Ellipse, Straight Line, Helix, Plane Curves. Tangent to a Curve (Review). Suggested problems: 1-20, 24-28 9.7 Gradient of a Scalar Field (Review). Suggested problems: 1-17, 24-26, 30-42 9.8 Divergence of a Vector Field. Suggested problems: 1-6, 9 9.9 Curl of a Vector Field. Suggested problems: 4-8, 14-20		1-4		A1
Chapter 10: Vector Integral Calculus. Integral Theorems 10.1 Line Integrals Suggested problems: 2-11, 15, 17, 18, 20 10.2 Path Independence of Line Integrals Suggested problems: 3-9, 13-19 10.3 Calculus Review: Double Integrals Suggested problems: 2-11		5-8		A1

10.4 Green's Theorem in the Plane Suggested problems: 1-10 10.5 Surfaces for Surface Integrals Suggested problems: 1-7, 14-18 10.6 Surface Integrals Suggested problems: 1-10, 12-16 10.7 Triple Integrals. Divergence Theorem of Gauss Suggested problems: 1-7, 9-18 10.9 Stokes's Theorem Suggested problems: 1-10				
Chapter 11: Fourier Analysis 11.1 Fourier Series Suggested problems: 1, 2, 6-10, 12-21 11.2 Arbitrary Period. Even and Odd Functions. Half-Range Expansions Suggested problems: 1-19, 23-29 11.7 Fourier Integral Suggested problems: 1-12, 16-20 11.8 Fourier Cosine and Sine Transforms Suggested problems: 1-3, 5, 8, 9-13 11.9 Fourier Transform Suggested problems: 2-11, 13 11.10 Tables of Transforms		9-12		A1
Chapter 12: Partial Differential Equations (PDEs) 12.1 Basic Concepts of PDEs Suggested problems: 3, 7, 11, 16-23 12.2 Modeling: Vibrating String, Wave Equation 12.3 Solution by Separating Variables. Use of Fourier Series Suggested problems: 5-14 12.6 Heat Equation: Solution by Fourier Series. Steady Two-Dimensional Heat Problems. Dirichlet Problem Suggested problems: 5-7, 12-16, 18, 19, 21, 23 12.7 Heat Equation: Modeling Very Long Bars. Solution by Fourier Integrals and Transforms Suggested problems: 2-6 12.10 Problem Set 12.10: Problems 4-8, 10 and 11. (Laplace equation in Polar Coordinate). Suggested problems: 4-8, 10, 11		13-15		A1

Learning Methodology

- In order to succeed in this course, you need to be an active participant in learning – both in class and out of class.
- Class time will be spent on lecture as well as discussion of homework problems and some group work.
- To actively participate in class, you need to prepare by reading the textbook and doing all assigned homework before class (homework will be assigned each class period, to be discussed the following period).
- You should be prepared to discuss your homework (including presenting your solutions to the class) at each class meeting - your class participation grade will be determined by your participation in this.
- You are encouraged to work together with other students and to ask questions and seek help from the professor, both in and out of class.

Evaluation

Evaluation	Point %	Date
Exam I	20 %	Week 5
Exam II	30 %	Week 10
Final Exam	50 %	

Main Reference/s:

Advanced Engineering Mathematics by E. Kreyszig, 10th Edition.

References:

1) Advanced Engineering Mathematics by Dennis G. Zill and Warren S. Wright, 5th edition.

2) Advanced Engineering Mathematics by K. A. Stroud and Dexter J. Booth, 5th edition

Intended Grading Scale (Optional)

0 - 39	**F**
40 - 49	**D-**
50 - 54	**D**
55 - 59	**D+**
60 - 64	**C-**
65 - 69	**C**
70 - 73	**C+**
74 - 76	**B-**
77 - 80	**B**
81 - 84	**B+**
85 - 89	**A-**
90 -100	**A**

Notes:

According to university regulations, attendance is mandatory. If a student is unable to attend a class, then he/she should contact the instructor. If a student misses more than 10% of the classes without excuse, then he/she will be assigned a falling grade in class.

In cases of extreme emergency or serious illness, the student will be allowed to make up the missed exams. Times and dates for make up exams will be assigned latter.

There are severe sanction for cheating, plagiarizing and any other form of dishonesty. The university regulations on cheating will be applied to any student who cheats in exams or on homework.