ENGINEERING MATHEMATICS IV

MAU22E02

HILARY TERM 2020/2021

PROF ANTHONY BROWN

Module description, aims and contribution to programme

This module is a natural continuation of the Junior Freshman modules MAU11E01 Engineering Mathematics I and MAU11E02 Engineering Mathematics II, and a companion module to the Senior Freshman module MAU22E01 Engineering Mathematics III, and introduces students to further fundamental ideas and methods of mathematics for engineering, covering the areas of multivariate calculus, integration and Laplace transforms. The aim of the module is to provide the necessary mathematical background and to teach students to use it efficiently.

Learning outcomes

On successful completion of this section of this module, students will be able to:

- Analyse the behaviour of functions of several variables, present the results graphically and efficiently calculate partial derivatives of functions of several variables (including functions given implicitly),
- Obtain equations for tangent lines to plane curves and tangent planes to space surfaces,
- Apply derivative tests to find local and global maxima and minima of functions of several variables,
- Calculate multiple integrals in Cartesian, polar, cylindrical and spherical coordinates, and in particular, find areas, volumes, masses and centres of gravity of two- and three-dimensional objects,
- Determine whether a vector field is conservative, find a potential function for a conservative field, and use it to calculate line integrals,
- Use Green's, Stokes' and the Divergence Theorems to calculate double, surface and flux integrals,
- Solve differential equations by applying Laplace transforms.

Lecture notes

Course notes, lecture notes, exercises, assignments and solutions will be available to download as the course progresses from Blackboard.

Textbooks

- Calculus, Late Transcendentals by Howard Anton, Irl C. Bivens and Stephen Davis, 9th Edition,
- Advanced Engineering Mathematics by Erwin Kreyszig, 8th Edition.

Lectures

There will be three online lectures each week starting in the week beginning February 1st. They will be held at the following days and times:

- Tuesdays 11.00,
- Thursdays 11.00,
- Fridays 14.00.

These lectures will be live on Zoom and you should all attend these.

The Zoom meeting details are:

Join Zoom Meeting using a Browser:
https://tcd-ie.zoom.us/j/7734585971

Join Zoom Meeting using the App:
Meeting ID: 773 458 5971

I will also be recording the lectures and putting them on Blackboard, just in case you have internet trouble during the live lecture.

Tutorials

There will be six tutorials each week starting in the second week of term, they will all be on Monday, and they will be at the following times, and you can join the tutorials by clicking on the links. Note that Pedro ptamarov@gmail.com will be teaching Groups 1, 3 and 5, and Camille stockc@tcd.ie will be teaching Groups 2, 4, and 6. Pedro will be using Microsoft teams, and the same link will be used for each of the tutorials. Camille will be using Zoom, and there is a different link for each of the times. The appropriate links are below.

- Group 1: 09.00, enter here.
- Group 2: 09.00, enter here
- Group 3: 12.00, enter here.
- Group 4: 12.00, enter here.
- Group 5: 13.00, enter here.
- Group 6: 13.00. enter here.

You should attend the one tutorial which has been assigned to you.
Pedro has agreed to record one of his tutorials to cater for those of you that cannot attend live.

Continuous Assessment

This will consist of five assignments during the semester.

Exam

There will be an exam during the middle of May.

Grading Policy

The continuous assessment will count for 50% of the final mark and the exam will count for the other 50%.

Contact details

If you wish to contact me outside lecture times then my contact details are as follows.

- My e-mail address is browna2@tcd.ie
- My mobile number is 087-9947027. I have given you my mobile number due to the times we are living in, but please only use it in emergencies.

Syllabus

(1) Vector-valued functions.
- Introduction to vector-valued functions,
- Calculus of vector-valued functions,
- Change of parameter; arc length,
- Unit tangent, normal and binormal vectors.

(2) Partial derivatives.
- Functions of two or more variables,
- Limits and continuity,
- Partial derivatives,
- Differentiability, differentials, and local linearity,
- The Chain Rule,
- Directional derivatives and gradients,
- Tangent planes and normal vectors
- Maxima and minima of functions of two variables.

(3) Multiple integrals.
- Double integrals,
- Double integrals over non-rectangular regions,
- Double integrals in polar coordinates,
- Surface area; parametric surfaces,
- Triple integrals,
- Triple integrals in cylindrical and spherical coordinates,
- Centres of gravity using multiple integrals,
- Change of variables in multiple integrals; Jacobians.

(4) Topics in vector calculus.
- Vector fields,
- Line integrals,
- Independence of path; conservative vector fields,
- Green's Theorem,
- Surface integrals,
- Application of surface integrals; flux,
- The Divergence Theorem,
- Stokes' Theorem.

(5) Laplace transforms.
- Laplace transforms; linearity; First Shifting Theorem,
- Transforms of derivatives; ODEs,
- Unit step function (Heaviside function); Second Shifting Theorem,
- Short impulses; Dirac's delta function,
- Convolutions.