Teaching Plan (Nov 2021 – March 2022)

Paper I: Calculus and Matrices

Course Objectives:

The primary objective of this course is to gain proficiency in differential calculus, and introduce the basic tools of matrices and complex numbers which are used to solve application problems in a variety of settings ranging from chemistry and physics to business and economics. Differential calculus develops the concepts of limit, continuity and derivative, and is fundamental for many fields of mathematics.

Course Learning Outcomes:

This course will enable the students to:

i) Define and use fundamental concepts of calculus including limits, continuity and differentiability.

ii) Solve systems of linear equations and find eigenvalues and corresponding eigenvectors for a square matrix, and check for its diagonalizability.

iii) Perform operations with various forms of complex numbers to solve equations.

Course Content:

Month	**Topic**
Nov	Unit II: Elementary row operations
Dec	Unit II: Row reduction and echelon forms, Solution of systems of linear equations in matrix form, Linear independence and dependence, Rank of a matrix and applications; Elementary linear transformations like shear, translation, dilation, rotation, refection, and their matrix form. ***Ungraded Class Assignment for Practice will be provided after each topic.***
Jan	Unit II: The matrix of a general linear transformation; Eigenvectors & eigenvalues of square matrices up to order 3 and diagonalization. Unit III: Geometrical representation of addition, subtraction, multiplication and division of complex numbers; Lines, circles, and discs in terms of complex variables. ***Graded Comprehensive Assignment and class test will be provided from Unit I as a part of Internal assessment.***
Feb	Unit III Statement of the Fundamental Theorem of Algebra and its consequences. De Moivre's theorem and its application to solve simple equations in complex variables. - Revision of Syllabus - Taking up doubts
March	- Extra practice to underperformers - Additional practice questions of higher difficulty order to meritorious students.

- To make the lectures interesting, use of PPTs and audio visual presentations will be made.
- The students would be encouraged to solve problems by applying the concepts learnt in assignments or tests.

References:

1. Andreescu, Titu & Andrica Dorin. (2014). Complex umbers from A to...Z. (2nd ed.). Birkhäuser.
2. Anton, Howard, Bivens, Irl, & Davis, Stephen (2013). Calculus (10th ed.). John Wiley & Sons Singapore Pvt. Ltd. Reprint (2016) by Wiley India Pvt. Ltd. Delhi.
3. Kolman, Bernard, & Hill, David R. (2001). Introductory Linear Algebra with Applications (7th ed.). Pearson Education, Delhi. First Indian Reprint 2003.
4. Lay, David C., Lay, Steven, R., & McDonald Judi, J. (2016). Linear Algebra and its Applications (5th ed.). Pearson.
5. Thomas, Jr. George B., Weir, Maurice D., & Hass, Joel (2014). Thomas' Calculus (13^{th} ed.). Pearson Education, Delhi. Indian Reprint 2017.

Additional Reading:

1. Prasad, Gorakh (2016). Differential Calculus (19th ed.). Pothishala Pvt. Ltd. Allahabad.

Teaching Plan (Jan 2022 – April 2022)

BMATH408: Partial Differential Equations

Course Objectives:

The main objectives of this course are to teach students to form and solve partial differential equations and use them in solving some physical problems.

Course Learning Outcomes:

This course will enable the students to:
i) Formulate, classify and transform first order PDEs into canonical form.
ii) Learn about method of characteristics and separation of variables to solve first order PDE's.
iii) Classify and solve second order linear PDEs.
iv) Learn about Cauchy problem for second order PDE and homogeneous and non-homogeneous wave equations.
v) Apply the method of separation of variables for solving many well-known second order PDEs.

Course Content:

Month	**Topic**
Jan	Unit 1: Introduction, Classification, Construction and geometrical interpretation of first order partial differential equations (PDE), Method of characteristic and general solution of first order PDE, Canonical form of first order PDE, Method of separation of variables for first order PDE.
Feb	Unit 2: Gravitational potential, Conservation laws and Burger's equations, Classification of second order PDE, Reduction to canonical forms, Equations with constant coefficients, General solution. ***Ungraded Class Assignment for Practice will be provided after each topic.***
March	Unit 3: Mathematical modeling of vibrating string and vibrating membrane, Cauchy problem for second order PDE, Homogeneous wave equation, Initial boundary value problems, Non-homogeneous boundary conditions, Finite strings with fixed ends, Non-homogeneous wave equation, Goursat problem. **All topics are covered in practical class too after classroom teaching.** ***Graded Comprehensive Assignment and class test will be provided from Unit I as a part of Internal assessment.***
April	Unit 4: Method of separation of variables for second order PDE, Vibrating string problem, Existence and uniqueness of solution of vibrating string problem, Heat conduction problem, Existence and uniqueness of solution of heat conduction problem, Non-homogeneous problem. - Revision of Syllabus - Taking up doubts

	- Extra practice to under performers - Additional practice questions of higher difficulty order to meritorious students.

- Each topic to be explained with illustrations using Mathematica.
- Students have been encouraged to look for new applications using the real life data sets.
- To make the lectures interesting, use of PPTs and audio visual presentations will be made.
- The students would be encouraged to solve problems by applying the concepts learnt in assignments or tests.

References:

1. Myint-U, Tyn & Debnath, Lokenath. (2007). Linear Partial Differential Equation for Scientists and Engineers (4th ed.). Springer, Third Indian Reprint, 2013.

Additional Reading:

i. Sneddon, I. N. (2006). Elements of Partial Differential Equations, Dover Publications. Indian Reprint.
ii. Stavroulakis, Ioannis P & Tersian, Stepan A. (2004). Partial Differential Equations: An Introduction with Mathematica and MAPLE (2nd ed.). World Scientific.

Teaching Plan (Jan,2022 – Apr, 2022)

SEC-4: Statistical Software: R

Course Objectives:

The purpose of this course is to help you begin using R, a powerful free software program for doing statistical computing and graphics. It can be used for exploring and plotting data, as well as performing statistical tests.

Course Learning Outcomes:

This course will enable the students to:
i) Be familiar with R syntax and use R as a calculator.
ii) Understand the concepts of objects, vectors and data types.
iii) Know about summary commands and summary table in R.
iv) Visualize distribution of data in R and learn about normality test.
v) Plot various graphs and charts using R.

Course Content:

Month	**Topic**
Jan	Unit 1: Introducing R, using R as a calculator; Explore data and relationships in R; Reading and getting data into R: combine and scan commands, viewing named objects and removing objects from R, Types and structures of data items with their properties, Working with history commands, Saving work in R.
Feb	Unit 1: Manipulating vectors, Data frames, Matrices and lists; Viewing objects within objects, Constructing data objects and their conversions. Unit 2: Summary commands: Summary statistics for vectors, Data frames, Matrices and lists; Summary tables. ***Ungraded Class Assignment for Practice will be provided after each topic.***
March	Unit 3: Stem and leaf plot, Histograms, Density function and its plotting, The Shapiro−Wilk test for normality, The Kolmogorov−Smirnov test. **All topics are covered in ICT lab after classroom teaching.** ***Graded Comprehensive Assignment and class test will be provided from Unit I as a part of Internal assessment.***
April	Unit 4: Plotting in R: Box-whisker plots, Scatter plots, Pairs plots, Line charts, Pie charts, Cleveland dot charts, Bar charts; Copy and save graphics to other applications. - Revision of Syllabus - Taking up doubts - Extra practice to under performers - Additional practice questions of higher difficulty order to meritorious students.

- Each topic to be explained with illustrations using R software.
- Students be encouraged to look for new applications using the real life data sets.
- To make the lectures interesting, use of PPTs and audio visual presentations will be made.
- The students would be encouraged to solve problems by applying the concepts learnt in assignments or tests.

References:

1. Bindner, Donald & Erickson, Martin. (2011). A Student's Guide to the Study, Practice, and Tools of Modern Mathematics. CRC Press, Taylor & Francis Group, LLC.
2. Gardener, M. (2012). Beginning R: The Statistical Programming Language, Wiley Publications.

Additional Reading:

1. Verzani, John (2014). Using R for Introductory Statistics (2nd ed.). CRC Press, Taylor & Francis Group.

Teaching Plan (April, 2022 – July, 2022)

Paper II: CALCULUS & GEOMETRY

Course Objectives:

The objectives of this course are to consider applications of derivatives for sketching of curves and conics and application of definite integrals for calculating volumes of solids of revolution, length of plane curves and surface areas of revolution which are helpful in understanding their applications in plenary motion, design of telescope and to many real-world problems.

Course Learning Outcomes:

This course will enable the students to:

i) Sketch curves in a plane using its mathematical properties in the different coordinate systems of reference.

ii) Compute area of surfaces of revolution and the volume of solids by integrating over cross-sectional areas.

iii) Be well-versed with conics and quadric surfaces so that they should able to relate the shape of real-life objects with the curves/conics.

Course Content:

Month	**Topic**
April	Unit I: The first derivative test for relative extrema, Concavity and inflection points, Second derivative test for relative extrema.
May	Unit I: Curve sketching using first and second derivative tests, Limits to infinity and infinite limits. Derivatives for Graphing and Applications Graphs with asymptotes, L'Hôpital's rule. ***Ungraded Class Assignment for Practice will be provided after each topic.***
June	Unit I: Parametric representation of curves and tracing of parametric curves (except lines in R) Derivatives for Graphing and Applications Polar coordinates and tracing of curves in polar coordinates. ***Graded Comprehensive Assignment and class test will be provided from Unit I as a part of Internal assessment.***
July	- Revision of Syllabus - Taking up doubts - Extra practice to underperformers - Additional practice questions of higher difficulty order to meritorious students.

- To make the lectures interesting, use of PPTs and audio visual presentations will be made.
- The students would be encouraged to solve problems by applying the concepts learnt in assignments or tests.

References:

1. Anton, Howard, Bivens, Irl, & Davis, Stephen (2013). Calculus (10th ed.). John Wiley & Sons Singapore Pvt. Ltd. Reprint (2016) by Wiley India Pvt. Ltd. Delhi.
2. Strauss, M. J., Bradley, G. L., & Smith, K. J. (2007). Calculus (3rd ed.). Dorling Kindersley (India) Pvt. Ltd. (Pearson Education). Delhi. Sixth impression 2011.