Bangladesh University of Engineering and Technology, Dhaka
Department of Mathematics

1. Bangladesh University of Engineering and Technology

As the premier institution of engineering and architecture education in the country, Bangladesh University of Engineering and Technology (BUET) has earned reputation in the South Asia and elsewhere in teaching, research, policy planning and public involvement. The university offers Bachelor, Masters and Ph.D. degrees in Architecture, Urban and Regional planning and different fields of engineering and Masters, M. Phil and Ph.D. degrees in Physics, Chemistry and Mathematics. Admission in this university is very competitive and only the top grade students succeed in getting admission. Teaching faculty strength is over 600 teachers, mid-level and senior teachers having Ph.D. degrees. Graduates of this university find employment not only in Bangladesh but also in other countries in the region including USA, Canada, Australia, UK, Malaysia, Singapore, Saudi Arabia and other Middle-east countries.

BUET has a good outreach program and offers education and training to practicing engineers and other professionals through its Continuing Education Centre. In addition to teaching and research, faculty members offer advisory services to the government organizations, companies and firms, and international organizations. Since its establishment as a university in 1962 from its predecessor Ahsanullah Engineering College, BUET has established and maintained academic linkage programmes with various universities of the glove. Notable among these are Academic Exchange Program with Texas A&M University in 1960s, University of Texas at Austin in 1994-96, Asian Institute of

Technology in 1988-91, University of Alberta Canada during 1989-2005, Delft University of Technology during 1992-2006, Exeter University and other universities in UK, several universities in Japan, Ireland, Belgium, etc.

The history of this university dates back to 1876 when Dhaka Survey School was established at Nalgola to train surveyors for the then Government of Bengal of British India. Subsequently, the Survey School became the Ahsanullah School of Engineering offering three year diploma courses in Civil, Electrical and Mechanical Engineering. In 1948, the School was upgraded to Ahsanullah Engineering College (on its present premises) as a Faculty of Engineering under the University of Dhaka, offering four-year Bachelor's courses in Civil, Electrical and Mechanical Engineering with a view to meet the increasing demand for engineers in the country and to expand the facilities for advancement of engineering education. In order to create facilities for postgraduate studies and research, Ahsanullah Engineering College was converted to East Pakistan University of Engineering and Technology in the year 1962. After independence of Bangladesh in 1971, it was renamed as the Bangladesh University of Engineering and Technology (BUET). Starting with two faculties, the university has now been expanded to five faculties.

2. The Campus and Facilities

The BUET campus is situated right at the heart of Dhaka City, the capital of Bangladesh with easy access to the Hazrat Shahjalal International Airport, Kamalapur Railway Station, Bus Terminals and Sadarghat River Port. The campus is compact with academic buildings, administrative building, library, medical centre, gymnasium, auditorium complex, cafeteria, central mosque, as well as students' halls of residences and teachers' residences being within walking distances. There are seven residential halls for male students and one for female students.

Computer and internet facilities are provided by the Institute of Information and Communication Technology (IICT) and Information and Communication Technology Cell (ICT Cell) located at the Electrical and Computer Engineering (ECE) Building. Sufficient internet facilities is also available at the central library. During academic sessions when classes are open, university bus service is available for off-campus students in the morning and in the late afternoon. Prior to availing such bus services students need to obtain bus tickets from Auto Shop of the university.

3. University Administration

Vice-Chancellor

Prof. Dr. Satya Prasid Majumder

Pro-Vice-Chancellor
Prof. Dr. Abdul Jabbar Khan

Deans of Faculties

Dean, Faculty of Architecture and Planning
Dean, Faculty of Science
Dean, Faculty of Chemical and Materials Engineering
Dean, Faculty of Civil Engineering
Dean, Faculty of Electrical and Electronic Engineering
Dean, Faculty of Mechanical Engineering

Heads of Departments

Head, Department of Chemical Engineering
Head, Department of Materials and Metallurgical Engineering
Head, Department of Petroleum and Minerals Resources Engineering
Head, Department of Nanomaterials and Ceramic Engineering

Head, Department of Chemistry
Head, Department of Mathematics
Head, Department of Physics
Head, Department of Civil Engineering
Head, Department of Water Resources Engineering
Head, Department of Mechanical Engineering
Head, Department of Naval Architecture and Marine Engineering
Head, Department of Industrial and Production Engineering
Head, Department of Electrical and Electronic Engineering
Head, Department of Computer Science and Engineering
Head, Department of Biomedical Engineering
Head, Department of Architecture
Head, Department of Humanities
Head, Department of Urban and Regional Planning

Directors of Institutes and Centres

Director, Institute of Water and Flood Management
Director, Institute of Appropriate Technology
Director, Institute of Information and Communication Technology
Director, Information and Communication Technology Cell
Director, Accident Research Institute
Director, BUET-Japan Institute of Disaster Prevention and Urban Safety
Director, Institute of Nuclear Power Engineering
Director, Institute of Energy and Sustainable Development
Director, Institute of Robotics and Automation
Director, Centre for Environmental and Resource Management
Director, Directorate of Continuing Education
Director, International Training Network Centre for Water Supply and Waste Management
Director, Bangladesh Network Office for Urban Safety
Director, Centre for Regional Development Studies
Director, Institutional Quality Assurance Cell

Director, Research and Innovation Centre for Science and Engineering
Director, Directorate of Continuing Education
Director, Planning and Development
Director, Directorate of Students Welfare
Director, Directorate of Advisory, Extension and Research Services
Director, Bureau of Research, Testing and Consultation

Provosts of Residential Halls

Provost, Ahsanullah Hall
Provost, Kazi Nazrul Islam Hall
Provost, Titumir Hall
Provost, Sher-e-Bangla Hall
Provost, Suhrawardy Hall
Provost, Shahid Smrity Hall
Provost, Sabequn Nahar Sony Hall
Provost, M. A. Rashid Hall
Provost, Bangamata Sheikh Fazilatunnesa Mujib Hall

Heads of Offices

Registrar
Controller of Examinations
Comptroller
Librarian

4. Faculties and Teaching Departments

The University has eighteen teaching departments under six faculties. All departments, with the exception of the Department of Humanities, offer degree programmes. Some departments offer postgraduate degrees only. Faculty-wise list of the departments with respective degree programmes is given below:

Faculty of Civil Engineering	
Department of Civil Engineering	UG and PG
Department of Water Resources Engineering	UG and PG
Faculty of Architecture and Planning	
Department of Architecture	UG and PG
Department of Urban and Regional Planning	UG and PG
Department of Humanities	No degree offered
Faculty of Electrical and Electronic Engineering	
Department of Electrical and Electronic Engineering	UG and PG
Department of Computer Science Engineering	UG and PG
Department of Biomedical Engineering	UG and PG
Faculty of Chemical and Materials Engineering	
Department of Chemical Engineering	UG and PG
Department of Materials and Metallurgical Engineering	UG and PG
Department of Petroleum and Mineral Resources Engineering	PG
Department of Nanomaterials and Ceramic Engineering	
Faculty of Science	
Department of Chemistry	PG
Department of Mathematics	PG
Department of Physics	PG
Faculty of Mechanical Engineering	
Department of Industrial and Production Engineering	UG and PG
Department of Mechanical Engineering	UG and PG
Department of Naval Architecture and Marine Engineering	UG and PG

5. Department of Mathematics

Introduction:

Mathematics plays an indispensable role in many fields including engineering, natural, social and medical sciences. This department is one of the oldest departments of this university. It started functioning from the very beginning of engineering education in this university and offers technology oriented undergraduate mathematics courses to all engineering, architecture and planning students at BUET and offers M.Sc., M. Phil. and Ph. D. degree in Mathematics. Each year this department is awarding a good number of M.Sc., M. Phil. degree in Mathematics in Bangladesh. Some postgraduate courses are also being offered for the students of the departments of Materials and Metallurgical Engineering, Water Resources Engineering, Naval Architecture and Marine Engineering, Glass and Ceramic Engineering etc.

The courses offered in this department are designed as per modern concepts of mathematics education. The department is offering postgraduate courses since 1986. Till then the department is running the courses and research works successfully for M.Sc., M.Phil and Ph.D. students. To date 39 M.Sc., 137 M.Phil., and 17 Ph.D. students have received their respective degrees from this department. At present, department has 75 M.Sc., 99 M.Phil., and 37 Ph.D. students.

The department has a computational laboratory for the research students. The research area includes but not limited to: Fluid dynamics and boundary layer theory, Computational fluid dynamics (CFD), Numerical heat transfer, Cooling tower computation, Refrigeration, Quantum mechanics, Graph theory; Ring and module theory, Numerical methods including Finite Difference Method, Finite Element Method and Finite Volume Method, Approximant method.

The department has now 23 faculty members, 5 office personnel. Some of our faculty members have recently joined into the department from home and abroad after completing their Ph.D. degree, which have enhanced our faculty strength.

The department has already achieved reputation through its research activities. The faculty members publish more than 60 conference and journal papers every year. Teachers of the department have published their papers in peer reviewed and highly reputed journals of the respective discipline. They are also actively involved in research activities with faculty members of other universities.

Teachers who contributed to the department as heads since 1962 are: Mr. Kazi Md. Zahiruddin, Mr. Md. Ali Ashraf, Mr. Md. Iman Ali, Dr. A. A. K. M. Shirajul Huque, Prof. Dr. Syed Ali Afzal, Prof. Dr. Md. Zakerullah, Prof. Dr. Md. Mustafa Kamal Chowdhury, Mr. Md. Abdul Khaleque Hazra, Prof. Dr. Nilufar Farhat Hossain, Prof. Dr. Md. Abdul Maleque, Prof. Dr. Md. Abdul Hakim Khan, Prof. Dr. Md. Elias, Prof. Dr. Md. Manirul Alam Sarker, Prof. Dr. Md. Abdul Alim, Prof. Dr. Md. Mustafizur Rahman and Prof. Dr. Md. Zafar Iqbal Khan. Prof. Dr. Khandker Farid Uddin Ahmed is the present Head of the Department.

Future plan

Subject to the availability of space and resources, the department has a plan to establish:

- Centre of Excellence for Engineering Mathematics Education at BUET.
- A high performance computational lab and research cell for improving quality of mathematics and computing education in Bangladesh.

During the celebration of the 60 Years of Engineering Education in Bangladesh, this department has organized a day long program of two sessions on November 4, 2007. In the Morning Session, there was a seminar on research presentations. The M.Phil. and Ph.D. students, including a research fellow, have presented their research papers in the seminar. Prof. Dr. Md. Mustafa Kamal Chowdhury was the session chair. In the Evening Session, there was a discussion program which includes a power point presentation on "Application of mathematics in engineering fields" presented by Dr. Md. Abdul Alim. As a keynote speaker, Prof. Dr. Md. Manirul Alam Sarker was the moderator in the session. Professor Dr. A. M. M. Safiullah, Vice-Chancellor of the university, graced the occasion as the chief guest.

List of Ex-Heads

Sl. No.	Name	Duration
1.	Mr. Kazi Md. Zahiruddin	21/02/1962 to 31/07/1970
2.	Mr. Md. Ali Ashraf	01/08/1970 to 30/09/1970
3.	Mr. Md. Iman Ali	01/10/1970 to 30/10/1970
4.	Dr. A. K. M. Shirajul Huque	01/11/1970 to 06/02/1976
5.	Mr. Md. Ali Ashraf	07/02/1976 to 30/04/1978
6.	Prof. Dr. Syed Ali Afzal	01/05/1978 to 14/11/1983
7.	Mr. Md. Ali Ashraf	15/11/1983 to 27/12/1985
8.	Prof. Dr. Md. Zakerullah	28/12/1985 to 13/08/1986
9.	Prof. Dr. Syed Ali Afzal	14/08/1986 to 22/08/1988
10.	Prof. Dr. Md. Zakerullah	23/08/1988 to 24/08/1990
11.	Prof. Dr. Syed Ali Afzal	25/08/1990 to 25/02/1992
12.	Prof. Dr. Md. Zakerullah	26/02/1992 to 25/02/1993
13.	Mr. Md. Ali Ashraf	26/02/1993 to 25/09/1995

14.	Prof. Dr. Md. Zakerullah	26/09/1995 to 25/09/1997
15.	Mr. Md. Mustafa Kamal Chowdhury	26/09/1997 to 25/09/1999
16.	Mr. Md. Abdul Khaleque Hazra	26/09/1999 to 25/09/2001
17.	Prof. Dr. Md. Mustafa Kamal Chowdhury	26/09/2001 to 26/09/2003
18.	Prof. Dr. Nilufar Farhat Hossain	27/09/2003 to 26/09/2005
19.	Prof. Dr. Md. Mustafa Kamal Chowdhury	27/09/2005 to 26/09/2007
20.	Prof. Dr. Md. Abdul Maleque	27/09/2007 to 29/09/2009
21.	Prof. Dr. Md. Abdul Hakim Khan	30/09/2009 to 30/09/2011
22.	Prof. Dr. Md. Elias	01/10/2011 to 30/09/2013
23.	Prof. Dr. Md. Manirul Alam Sarker	01/10/2013 to 02/10/2015
24.	Prof. Dr. Md. Abdul Alim	03/10/2015 to 03/10/2017
25	Prof. Dr. Md. Mustafizur Rahman	04/10/2017 to 05/10/2019
26	Prof. Dr. Md. Zafar Iqbal Khan	06/10/2019 to 05/03/2021
27	Prof. Dr. Khandker Farid Uddin Ahmed	06/03/2021 to ----------

Faculty Members of the Department

Professor and Head

Dr. Khandker Farid Uddin Ahmed, B.Sc. (Hons.), M.Sc., University of Dhaka, M.Phil., BUET, Ph.D., Mahidol University, Thailand (*Ring and Module Theory, Graph theory*)

Professors

Dr. Md. Abdul Hakim Khan, B.Sc. (Hons.), M.Sc., University of Dhaka, M.Phil., BUET, Ph.D., University of Bristol, UK (*Approx. Methods & Fluid Dynamics*)

Dr. Md. Manirul Alam Sarker, B.Sc. (Hons.), M.Sc., University of Dhaka, M.Stat., Belgium, Ph.D., Pukyong National University, South Korea (*Numerical Heat Transfer, Cooling Tower Computation, Statistical Models*)

Dr. Md. Abdul Alim, B.Sc. (Hons.), M.Sc., University of Dhaka, M.Phil., BUET, Ph.D., Lougborough University, UK (*Computational Fluid Dynamics (CFD), Combustion, Heat Transfer*)

Dr. Md. Mustafizur Rahman, B.Sc. (Hons.), M.Sc., University of Dhaka, M.Phil., BUET, Ph.D., BUET (*Fluid Dynamics, Heat Transfer*)

Dr. Md. Zafar Iqbal Khan, B.Sc. (Hons.), M.Sc., University of Dhaka, M.Phil., BUET, Ph.D., Tokyo University of Agriculture and Technology, Japan (*Fluid Dynamics,Renewable Energy, Refrigeration & Cooling System*)

Dr. Khandker Farid Uddin Ahmed, B.Sc. (Hons.), M.Sc., University of Dhaka, M.Phil., BUET, Ph.D., Mahidol University, Thailand (*Ring and Module Theory, Graph theory*)

Dr. Nazma Parveen, B.Sc. (Hons.), M.Sc., University of Dhaka, M.Phil., BUET, Ph.D., BUET (*Fluid Dynamics*)

Dr. Mohammed Forhad Uddin, B.Sc. (Hons.), M.Sc., University of Dhaka, M.Phil., BUET, Ph.D., Nagaoka University of Technology, Japan (*Logistics, Optimization, SCM*)

Dr. Salma Parvin, B.Sc. (Hons.), M.Sc., University of Dhaka, M.Phil., BUET, Ph.D., BUET (*Quantum Mechanics, CFD*)

Dr. Rehena Nasrin, B.Sc. (Hons.), M.Sc., University of Dhaka, M.Phil., BUET, Ph.D., BUET, (*Computational Fluid Dynamics, Numerical Heat & Mass Transfer, Theory of Relativity, Solar Energy*)

Assistant Professor

Dr. Ishrat Zahan, B.Sc. (Hons.), M.Sc., University of Dhaka, M.Phil., BUET, Ph.D. BUET *(Population Ecology, Computational Fluid Dynamics, Numerical Heat & Mass Transfer, Fuzzy Mathematics)*

Dr. K. M. Ariful Kabir, B.Sc. (Hons.), M.Sc., University of Dhaka, M.Phil., BUET, Ph.D., Kyushu University, Japan (*Epidemiology, Evolutionary Game Theory, Traffic Flow Analysis, Solar Thermal Energy, Quantum Mechanics*)

Lecturer

Mr. Md. Ashraf Hossain, B.Sc. (Hons.), M.Sc., University of Dhaka
Mr. Md. Saddam Hossain, B.Sc. (Hons.), M.Sc., University of Dhaka
Ms. Shikha Saha, B.Sc. (Hons.), M.Sc., University of Dhaka
Mr. Md. Nahid Hasan, B.Sc. (Hons.), M.Sc., University of Dhaka

Study Leave

Mr. Sajid Ahmed, B.Sc. (Hons.), M.Sc., University of Dhaka (*Fluid Dynamics, Theory of Relativity*)
Mr. Abdul Halim Bhuiyan, B.Sc. (Hons.), M.Sc., University of Dhaka, M.Phil., BUET, (*Dynamical System, CFD*)
Mr. Shohel Ahmed, B.Sc. (Hons.), M.Sc., University of Dhaka, M.Phil., BUET.
Mrs. Afroza Akter, B.Sc. (Hons.), M.Sc., University of Dhaka, M.Phil., BUET.
Mrs. Maria Akter, B.Sc. (Hons.), M.Sc., University of Dhaka, M.Phil., BUET.
Mr. Murshed Ahmed Ovi, B.Sc. (Hons.), M.Sc., University of Dhaka
Mr. Khondoker Nazmoon Nabi, B.Sc. (Hons.), M.Sc., University of Dhaka

6. DETAILS OF UNDERGRADUATE COURSES OFFERED BY DEPARTMENT OF MATHEMATICS TO STUDENTS OF DIFFERENT DEPARTMENTS

For the Department of Urban and Regional Planning

Level-1, Term-1
MATH 105 (Mathematics I)
3.00 Credit Hours

Functions: Families of functions. Properties and graphs of functions. Composite functions. Inverse functions. Polynomial and rational functions. Hyperbolic functions. Trigonometric functions. Exponential and Logarithmic functions. Applications.

Matrices: Algebra of matrices. Determinants. Gaussian elimination. Inverse of a matrix. Solutions of linear systems of equations. Rank and elementary transformation of matrices. Matrix polynomials. Eigenvalues and eigenvectors.

Solid Geometry: System of coordinates. Direction cosines. Equations of planes and straight lines. Shortest distance between two given straight lines. Standard equations of sphere and ellipsoid. Tangent planes.

Level-1, Term-2
MATH 107 (Mathematics II)
3.00 Credit Hours

Differential Calculus: Limits, continuity and differentiability. Successive differentiation. Maxima and minima of functions of single variable. Applications.

Integral Calculus: Integration by substitution and by parts. Standard integrals. Definite integrals. Area under plane curves. Applications.

Ordinary Differential Equations: Solution of first order differential equations by various methods. Solution of general linear equations of second and higher order with constant coefficients. Solution of homogeneous linear equations. Applications.

Fourier Analysis: Real and complex form of Fourier series. Finite Fourier transform. Fourier integrals. Fourier transforms and their uses in solving boundary value problems. Fourier transform of Gaussian function.

For the Department of Architecture

Level -1, Term-1
MATH 111 (Mathematics)
2.00 Credit Hours

Differential Calculus: Definition of limit, continuity and differentiability. Successive and partial differentiation. Maxima and minima.

Integral Calculus: Integration by parts, standard integrals. Definite integrals. Area under plane curves in Cartesian coordinates.

Solid Geometry: System of coordinates. Distance between two points. Section formula. Direction cosines. Equations of planes and straight lines. Shortest distance between two given straight lines. Standard equations of sphere and ellipsoid. Tangent planes.

For the Department of Nanomaterials and Ceramic Engineering

Level-1, Term-1
MATH 112 (Calculus)
3.00 Credit Hours

Differential Calculus: Limits, continuity and differentiability for functions of single and multi-variables. Successive differentiation. Leibnitz's theorem. Expansion of functions. Partial differentiation, Euler's theorem. Tangent and Normal. Subtangent and subnormal in Cartesian and polar coordinates. Determination of maxima and minima for functions of single and multi-variables with applications. Envelopes, curve tracing. Asymptotes.

Integral Calculus: Standard integrals. Integration by successive reduction. Definite integrals and its properties. Area under plane curves and area of a region enclosed by two curves in Cartesian and polar coordinates. Improper integrals. Beta and Gamma functions. Volume and surface area of solids of revolution. Double integrals in polar coordinates. Triple integrals in cylindrical and spherical coordinates.

Level-1, Term-2
MATH 114 (Differential Equations)
3.00 Credit Hours

Ordinary Differential Equations: Formation of differential equations. Solution of first order differential equations by various methods with applications. Solutions of general linear differential equations of second and higher order with constant coefficients with applications. Cauchy-Euler differential equations. Solutions of differential equations of higher order when dependent and independent variables are absent. Solutions of differential equations by the method based on factorization of operators. Fröbenius method.

Partial Differential Equations: Formation of partial differential equations. Solutions of linear and nonlinear partial differential equations of first order. Linear partial differential equations of second and higher order. Partial differential equations of second and higher order with variable coefficients. Heat and Wave equations.

Level-2, Term-1
MATH 212 (Linear Algebra and Statistics)
3.00 Credit Hours

Linear Algebra: Introduction to systems of linear equations. Gaussian elimination. Inverse of a matrix. Eigen values and eigenvectors. Cayley-Hamilton theorem. Euclidean n-space. Linear transformations from $\mathbb{R}^n$ to $\mathbb{R}^m$. Properties of linear transformations from $\mathbb{R}^n$ to $\mathbb{R}^m$. Real vector spaces and subspaces. Basis and Dimension, Rank and Nullity. Inner product spaces. Diagonalization. General linear transformations: Kernel and Range.

Statistics: Descriptive statistics. Elementary probability theory. Discrete probability distributions (Binomial, Poisson and Negative binomial distribution). Continuous probability distributions (Normal and Exponential distribution). Hypothesis testing. Correlation and Regression. Time series analysis. Markov chain.

Level-2, Term-1
MATH 214 (Vector Calculus, Tensor and Fourier Analysis)
3.00 Credit Hours

Vector Calculus: Differentiation and integration of vectors together with elementary applications. Line, surface and volume integrals. Gradient of a scalar function, divergence and curl of a vector function. Integral forms of gradient, divergence and curl. Green's theorem in the plane. Gauss's divergence theorem and Stokes' theorem.

Tensor Analysis: Introduction to tensors. Allowable transformations of coordinate systems. Illustration of a transformation and its Jacobian matrix. Metric tensor. Christoffel symbols.

Fourier Analysis: Real and complex form of Fourier series. Finite Fourier transform. Fourier Integral. Fourier transforms and their uses in solving boundary value problems.

For the Department of Biomedical Engineering

Level-1, Term-1
MATH 113 (Calculus)
3.00 Credit Hours

Differential Calculus: Limits, continuity and differentiability. Successive differentiation of various types of functions. Leibnitz's theorem. Rolle's theorem, Mean value theorem, Taylor's and Maclaurin's theorems in finite and infinite forms. Expansion of functions. Evaluation of indeterminate forms by L'Hospital's rule. Partial differentiation, Euler's theorem. Tangent and Normal. Subtangent and subnormal in Cartesian and polar coordinates. Determination of maximum and minimum values of functions with applications. Curvature. Asymptotes.

Integral Calculus: Integration by the method of substitution. Standard integrals. Integration by successive reduction. Definite integrals, its properties and use in summing series. Walli's formulae. Improper integrals. Beta function and Gamma function. Area under plane curves and area of a region enclosed by two curves in Cartesian and polar coordinates. Volume and surface area of solids of revolution.

Level-1, Term-2
MATH 115 (Complex Variable and Vector Calculus)
3.00 Credit Hours

Complex Variable: Complex number system. General functions of a complex variable. Limits and continuity of functions of complex variables and related theorems. Complex differentiation and the Cauchy-Riemann equations. Infinite series and their convergence. Line integral of complex functions. Cauchy's integral formula. Liouville's theorem. Taylor's and Laurent's theorem. Singular points. Residue, Cauchy's residue theorem.

Vector Calculus: Differentiation and integration of vectors together with elementary applications. Line, surface and volume integrals. Gradient of a scalar function, divergence and curl of a vector function. Integral forms of gradient, divergence and curl. Gauss's divergence theorem, Stokes' theorem and Green's theorem for the plane.

Level-2, Term-1
MATH 213 (Differential Equations)
3.00 Credit Hours

Ordinary Differential Equations: Formation of differential equations. Solution of first order differential equations by various methods. Solution of general linear equations of second and higher order with constant coefficients. Solution of homogeneous linear equations. Solution of differential equations of the higher order when dependent and independent variables are absent. Solution of differential equations by the method based on factorization of operators. Fröbenius method.

Partial Differential Equations: Formation of partial differential equations. Solutions of linear and nonlinear partial differential equations of first order. Linear equations of higher order. Equations of the second order with variable coefficients. Wave equations. Particular solutions with boundary and initial conditions.

Level-2, Term-2
MATH 215 (Linear Algebra)
3.00 Credit Hours

Definition of matrices. Algebra of matrices. Transpose of a matrix and inverse of a matrix. Factorization. Determinants. Quadratic forms. Matrix polynomials. Eigenvalues and eigenvectors. Diagonalization.

Introduction to systems of linear equations. Gaussian elimination. Euclidean n-space. Linear transformations from $\mathbb{R}^n$ to $\mathbb{R}^m$. Properties of linear transformations from $\mathbb{R}^n$ to $\mathbb{R}^m$. Real vector spaces and subspaces. Basis and Dimension. Row space, column space and null space. Rank and Nullity. Inner products. Angle and orthogonality in inner product spaces. Orthogonal basis: Gram-Schmidt process and QR-Decomposition. Linear transformations: Kernel and Range. Application to Computed Tomography.

Level-3, Term-1
MATH 313 (Probability and Statistics)
3.00 Credit Hours

Measures of central tendency and variation, Frequency distribution; Graphical representation of data: stem, leaf, box plot; Skewness; Moment; Kurtosis; Probability theory: rules of probability, conditional probability, Bayes's theorem, odds ratios, counting techniques; Random variable: concept of random variable, discrete and continuous random variable, variance of random variable and their properties; Joint distribution, Marginal distribution, Density; Discrete and continuous probability distributions: binomial, Poisson, normal, exponential, uniform. Transformation of random variables-one, two and N random variables, central limit theorem; Sampling theory: sampling distribution of mean and sampling procedures; Z-scores, Chebychev's theorem, Regression and Correlation: Pearson's correlation, Spearman correlation, Linear regression, Statistical Inference: estimation of parameters; Analysis of variance: ANOVA; Hypothesis testing: z-test, t-test.

For the Department of Chemical Engineering

Level-1, Term-1
MATH 125 (Calculus)
3.00 Credit Hours

Differential Calculus: Continuity and differentiability of a function; Successive differentiation of various types of functions; Leibnitz's theorem; Rolle's theorem; Mean value theorem and expansion of functions; Partial differentiation; Tangent and normal in the cases of Cartesian and polar co-ordinates; Maxima and minima; Indeterminate forms.

Integral Calculus: Integration by methods of substitution; Integration by the method of successive reduction; Definite integrals with properties; Improper integrals; Beta and Gamma function; Area under a plane curve in Cartesian and polar co-ordinates; Area of the region enclosed by the two curves in Cartesian and polar co-ordinates; Arc lengths of curves in Cartesian and polar co-ordinates; Area and volume of a surface of revolution.

Level-1, Term-2
MATH 127 (Linear Algebra and Vector Calculus)
3.00 Credit Hours

Linear Algebra: Introduction to systems of linear equations; Gaussian elimination; Matrix polynomials; Euclidean n-space; Linear transformations from $\mathbb{R}^n$ to $\mathbb{R}^m$; Properties of linear transformations from $\mathbb{R}^n$ to $\mathbb{R}^m$; Real vector spaces and subspaces; Basis and dimension; Rank and nullity; Inner product spaces; Gram-Schmidt process; Eigenvalues and eigenvectors; Diagonalization; Linear transformation; Kernel and range; Application of linear algebra to chemical engineering.

Vector Calculus: Differentiation and integration of vectors together with elementary applications; Definition of line, surface and volume integrals; Gradient, divergence and curl of point functions; Gauss's theorem, Stokes' theorem and Green's theorem, and their applications.

Level-2, Term-1

MATH 225 (Differential Equations and Laplace Transforms)
3.00 Credit Hours

Ordinary Differential Equations: Solutions of first order differential equations by various methods; Solutions of general linear equations of second and higher order with constant coefficients; Solution of homogeneous linear equations and applications; Solutions of differential equations of the higher order when dependent and independent variables are absent.

Partial Differential Equations: Introduction; Equations of linear and non-linear first order partial differential equations; Standard forms; Linear equations of higher order; Equations of the second order with variable coefficients.

Laplace Transforms: Definition; Laplace transform of some elementary functions; Sufficient conditions for existence of Laplace transforms; Inverse Laplace transforms; Laplace transforms of derivatives; The unit step function; Periodic functions; Some special theorems on Laplace transforms; Partial fraction; Solutions of differential equations by Laplace transforms; Evaluation of improper integrals.

Level-2, Term-2

MATH 227 (Engineering Statistics and Data Analysis)
4.00 Credit Hours

Concept of sample and population; measures of location: mean, median, mode, percentiles and quartiles; Measures of variability: range, interquartile range, variance, standard deviation, coefficient of variation and box plots, moments, skewness and kurtosis; Random variable and its probability distribution; Probability; Conditional probability; Addition and multiplication rules of probability; Bayes' theorem; Distributions: normal, exponential, gamma, weibull; Test of hypotheses: z-test, t-test, chi-squared test, F-test; Concept of p-value; Interval estimation; Central limit theorem; Simple linear regression and its properties including test of fitness, correlation and preliminary data reconciliation.

Sessional: Data and Data file; Data entry program; Range check, logical (consistency check), etc.; Operations with data variables; Data management and presentation. Data manipulation and transformation: Inserting variables and cases; Merging and splitting files; Recoding; Selection of a random sample; Numerical description of data using central tendency, dispersion, skewness and kurtosis; Parameter estimation for regression line; Sampling distribution; Calculation of p-value; Analysis of variance (ANOVA).

Software: SPSS/ Minitab, etc.

Level-3, Term-1

MATH 325 (Fourier Analysis and Special Functions)
3.00 Credit Hours

Fourier Analysis: Real and complex form; Finite transform; Fourier integral; Fourier transforms and their uses in solving boundary value problems including 2D heat equation.

Bessel Functions and Legendre Polynomials: Solution of differential equations in series by the Fröbenius method; Bessel's functions; Legendre's polynomials and their properties.

Level-3, Term-2
MATH 327 (Multivariable Statistical Analysis and Complex Analysis)
3.00 Credit Hours

Multivariable Statistical Analysis: Aspects of multivariable analysis; Multivariate normal distribution; Inferences about mean and variances (MANOVA); Multivariate linear regression; Principal component analysis.

Complex Variable: Complex number system; General functions of a complex variable; Limits and continuity of a function of complex variable and related theorems; Complex differentiation and the Cauchy-Riemann equations; Mapping by elementary functions; Line integral of a complex function; Cauchy's integral theorem; Cauchy's integral formula; Residue; Cauchy's residue theorem; Evaluation of residues; Contour integration; Conformal mapping.

For the Department of Civil Engineering

Level-1, Term-1
MATH 137 (Differential and Integral Calculus, Matrices)
3.00 Credit Hours

Differential Calculus: Limit, Continuity and differentiability; Successive differentiation and Leibnitz's theorem; Expansion of functions; Indeterminate forms; Partial differentiation; Euler's theorem; Tangent and Normal; Maxima and minima of functions of single variable.

Integral Calculus: Integration by parts; Standard integrals; Integration by the method of successive reduction; Definite integrals; Beta function; Gamma function; Multiple integrals.

Matrices: Definition of different kinds of matrices; Algebra of matrices; Inverse of matrix; Rank and elementary transformation of matrices; Solution of system of linear equations; Eigen values and eigen vectors; Cayley-Hamilton theorem.

Level-1, Term-2
MATH 139 (Differential Equations and Statistics)
3.00 Credit Hours

Ordinary Differential Equation: Formation of differential equations; Solution of first order differential equations by various methods; Solution of differential equation of first order but higher degree; Solution of general linear equations of second and higher order with constant co-efficient; Solution of Euler's homogeneous linear differential equations.

Partial Differential Equation: Introduction, Linear and non-linear first order differential equations; Standard forms; Linear equations of higher order; Equations of the second order with variable co-efficient.

Statistics: Measures of central tendency and standard deviation; Moments, Skewness and Kurtosis; Elementary probability theory and discontinuous probability distribution; Continuous probability distributions, e.g. normal and exponential.

Level-2, Term-1
MATH 237 (Laplace Transforms and Vector Analysis)
3.00 Credit Hours

Laplace Transforms: Definition of Laplace transform, Sufficient conditions for existence of Laplace transforms; Inverse Laplace transforms; Laplace transforms of derivatives; The unit step function; Periodic function; Some special theorems on Laplace transforms; Partial fraction; Solutions of differential equations by Laplace transforms.

Vector Analysis: Scalars and vectors, equality of vectors; Addition and subtraction of vectors; Multiplication of vectors by scalars; Position vector of a point; Scalar and vector product of two vectors and their geometrical interpretation; Triple products and multiple products of vectors; Linear dependence and independence of vectors; Definition of line, surface and volume integral; Gradient, divergence and curl of point functions; Gauss's theorem, Stokes' theorem, Green's theorem and their applications.

For the Department of Water Resources Engineering

Level-1, Term-1
MATH 131 (Differential Calculus and Integral Calculus)
3.00 Credit Hours

Differential Calculus: Limit, continuity and differentiability. N-th derivatives of standard functions. Leibnitz's theorem. Rolle's theorem, Mean value theorem. Expansion in finite and infinite forms. Indeterminate form. Partial differentiation. Euler's theorem. Tangent and Normal. Subtangent and subnormal in Cartesian and polar co-ordinates. Maxima and minima of functions of single variable. Curvature.

Integral Calculus: Integration by parts. Standard integrals. Integration by the method of successive reduction. Definite integrals. Improper integrals. Beta function. Gamma function. Multiple integrals. Area and volume of solids of revolution.

Level-1, Term-2
MATH 133 (Matrices and Coordinate Geometry)
3.00 Credit Hours

Matrices: Definition of matrix. Algebra of matrices. Multiplication of matrices. Transpose of a matrix and inverse of a matrix. Rank and elementary transformations of matrices. Solution of linear equations. Linear dependence and independence of vectors. Quadratic forms. Matrix polynomials. Determination of

characteristic roots and vectors. Null space and nullity of a matrix. Characteristic subspace of a matrix.

Three Dimensional Coordinate Geometry: System of coordinates. Projection. Direction cosines. Equations of planes and lines. Angle between lines and planes. Distance from a point to a plane. Coplanar lines. Shortest distance between two given straight lines. Standard equation of conicoid: Sphere, ellipsoid, hyperboloid of one sheet, hyperboloid of two sheets. Tangent planes. Normal lines. Condition of tangency.

Level-2, Term-1
MATH 231 (Differential Equations)
3.00 Credit Hours

Differential Equations: Definition. Formation of differential equations. Solution of first order differential equations by various methods. Solution of differential equations of first order and higher degree. Solution of general linear equations of second and higher order with constant coefficients. Solution of Euler's homogeneous linear equations. Solution of differential equations in series by the method of Fröbenius. Bessel's functions, Legendre's polynomials and their properties.

Partial Differential Equations: Introduction. Solutions of linear and nonlinear differential equations of first order. Standard forms. Linear equations of higher order. Equations of the second order with variable coefficients.

Level-2, Term-2
MATH 233 (Fourier Analysis, Harmonic Functions and Laplace Transforms)
3.00 Credit Hours
Fourier Analysis: Real and complex form of Fourier series. Finite Fourier transform. Fourier integrals. Fourier transforms and their uses in solving boundary value problems.

Harmonic functions: Definition of harmonics. Laplace's equation in Cartesian, polar, cylindrical and spherical coordinates. Solution of these equations together with applications. Gravitational potential due to a ring. Steady-state temperature. Potential inside or outside a sphere. Properties of harmonic functions.

Laplace Transforms: Definition. Laplace transform of some elementary functions. Sufficient conditions for existence of Laplace transforms. Inverse Laplace transforms. Laplace transforms of derivatives. The unit step function. Periodic functions. Some special theorems on Laplace transforms. Partial fraction. Solution of differential equations by Laplace transforms. Evaluation of improper integrals by Laplace transforms.

Level-2, Term-2
MATH 235 (Vector Analysis and Statistics)
3.00 Credit Hours

Vector Analysis: Scalars and vectors, equality of vectors. Addition and subtraction of vectors. Multiplication of vectors by scalars. Position vector of a point. Resolution of vectors. Scalar and vector product of two vectors and their geometrical interpretation. Triple product and multiple product. Application to geometry and mechanics. Linear dependence and independence of vectors. Differentiation and integration of vectors together with elementary applications. Definition of line, surface and volume integrals. Gradient, divergence and curl of point functions. Various formulae: Gauss's theorem, Stokes' theorem, Green's theorem and their applications.

Statistics: Frequency distribution. Mean, median, mode and other measures of central tendency. Standard deviation and other measures of dispersion. Moments, skewness and kurtosis. Elementary probability theory and discontinuous probability distribution, e.g. binomial, Poisson and negative binomial. Continuous probability distributions, e.g. normal and exponential. Characteristics of distributions. Elementary sampling theory. Estimation. Hypothesis testing and regression analysis.

For the Department of Computer Science and Engineering

Level-1, Term-1
MATH 141 (Calculus I)
3.00 Credit Hours

Differential Calculus: Continuity and differentiability; Successive differentiation: Leibnitz's forms; Maxima and minima of functions of single variable: Rolle's theorem, Mean value theorem; Evaluation of indeterminate forms by L'Hospital's rule; Expansion of functions: Taylor's and Maclaurin's theorems, Lagrange's and Cauchy's forms of remainders; Partial differentiation, Euler's theorem; Tangent, normal.

Integral Calculus: Definite integrals and its properties; Walli's formula; Improper integrals; Beta function and Gamma function; Parametric equations and polar coordinates; Applications of integration: area under a plane curve, area of a region enclosed by two curves and arc lengths in Cartesian and polar coordinates, volume and surface area of solids of revolution; Multiple integrals.

Ordinary Differential Equations (ODE): Definition. Formation of differential equations. Solution of first order differential equations by various methods with applications. Solution of general linear equations of second and higher order with constant coefficients. Solution of Euler's homogeneous linear equations.

Level-1, Term-2
MATH 143 (Linear Algebra)
3.00 Credit Hours

Introduction to vectors, their products, matrices and systems of linear equations; Solving linear systems: Gaussian elimination, inverse and transpose of a matrix, factorization into $\boldsymbol{A} = \boldsymbol{LU}$; Vector spaces and subspaces: four fundamental subspaces, solving $\boldsymbol{Ax} = \mathbf{0}$ and $\boldsymbol{Ax} = \boldsymbol{b}$, independence, basis and dimension, dimensions of the four subspaces; Orthogonality: orthogonality of the four subspaces, projections, least squares, orthonormal bases and Gram-Schmidt; Determinants: properties, formulas, Cramer's rule, inverses and volumes; Eigenvalues and eigenvectors: eigen decomposition, systems of differential equations, symmetric and positive definite matrices; Singular value decomposition (SVD): bases and matrices in the SVD, geometry of the SVD; Linear transformations: the matrices of linear transformations; Complex vectors and matrices: complex numbers, polar coordinates, Hermitian and unitary matrices; Applications of linear algebra in computer science and engineering.

Level-2, Term-1
MATH 241 (Advanced Calculus)
3.00 Credit Hours

Vector Calculus: Vector and scalar fields; Differentiation and integration of vectors; Gradient of a scalar field: directional derivative; Divergence and curl of a vector field; Vector calculus identities: Jacobian, Hessian, Laplacian; Line integrals.

Complex Calculus: Functions of a complex variable; Limits and continuity of functions of complex variables; Complex differentiation: analytic functions, Cauchy-Riemann equations; Elementary complex functions: exponential, trigonometric, hyperbolic; Line integral of a complex function.

Partial Differential Equations (PDE): Introduction and formation of PDE; Solution of linear and non-linear PDE of order one; Second order linear PDE: classifications to standard forms; Parabolic, elliptic, hyperbolic; Solution of second order linear PDE by separation of variables.

Level-2, Term-2
MATH 243 (Probability and Statistics)
3.00 Credit Hours

Introduction to Statistics, variability in data, populations and samples, descriptive statistics, inferential statistics and probability, sampling procedures; Measures of location: mean, median; Measures of variability: standard deviation, variance; Higher moments: skewness, kurtosis; Graphical representation of data: scatter plot, stem and leaf plot, histogram, box plot; Probability: sample space and events, rules of probability, conditional probability, independence, Bayes' rule; Random variables: discrete and continuous probability distributions, joint probability distributions, marginal distributions and independence; Expectations, variance and covariance of random variables and their properties, Chebyshev's theorem; Discrete probability distributions: Bernoulli, binomial, multinomial, Poisson distributions and their properties; Continuous probability distributions: uniform, Gaussian (normal), chi-square distributions and their properties; Sampling distributions: sample mean, central limit theorem, sample variance, t-distribution, F-distribution, quantile and probability plots; Statistical inference: parameter estimation, confidence intervals; Hypothesis testing: null and alternative hypotheses, test statistic, P-values and significance levels, Z-test, t-test, goodness-of-fit test; Regression and correlation: least squares, coefficient of determination, correlation coefficient; Analysis of variance (ANOVA).

Level-4, Term-1
MATH 441 (Mathematical Optimization)
3.00 Credit Hours

Introduction; Classical methods with single and multi-variables; Basics of mathematical programming; Linear programming; Graphical method with mathematical definitions and theorems; Nonlinear programming: one dimensional problems by elimination and interpolation methods; Unconstrained and constrained techniques; Geometrical programming, stochastic programming; Calculus of variations; Optimality and relaxation, Lagrangian relaxation; Convexity and subgradient Optimization; Subgradient optimization for the Lagrangian dual.

Level-4, Term-1
MATH 443 (Game Theory)
3.00 Credit Hours

Introduction to game theory and its applications; Solution concepts: dominant strategies, pure and mixed strategies, Nash equilibrium; Zero sum games: two-player zero-sum games, existence of Nash equilibria, computation by linear programming, multiplayer zero-sum games; Learning in games: fictitious play, multiplicative weights updates; Price of anarchy: congestion games, potential games, existence of equilibria; Market equilibria: Arrow-Debreu existence theorem; Mechanism design: Vickrey auction, social choice theory, Arrow's impossibility theorem, Vickrey-Clarke-Groves (VCG) mechanism, application of the VCG mechanism in routing, Myerson auction; Evolutionary game theory.

For the Department of Electrical and Electronic Engineering

Level-1, Term-1
MATH 157 (Calculus I)
3.00 Credit Hours

Differential Calculus: Limits, continuity and differentiability. Successive differentiation of various types of functions. Leibnitz's theorem. Rolle's theorem, Mean value theorem, Taylor's and Maclaurin's theorems in finite and infinite forms. Lagrange's form of remainder. Cauchy's form of remainder. Expansion of functions. Evaluation of indeterminate forms by L'Hospital's rule. Partial differentiation, Euler's theorem. Tangent and Normal. Subtangent and subnormal in Cartesian and polar coordinates. Determination of maximum and minimum values of functions. Curvature. Asymptotes and curve tracing.

Integral Calculus: Integration by the method of substitution. Standard integrals. Integration by successive reduction. Definite integrals, its properties and use in summing series. Walli's formulae. Improper integrals. Beta function and Gamma function. Area under plane curves and area of a region enclosed by two curves in Cartesian and polar coordinates. Volume and surface area of solids of revolution.

Level-1, Term-1
MATH 159 (Calculus II)
3.00 Credit Hours

Complex Variable: Complex number system. General functions of a complex variable. Limits and continuity of functions of complex variables and related theorems. Complex differentiation and the Cauchy-Riemann equations. Infinite series. Convergence and uniform convergence. Line integral of complex functions. Cauchy's integral formula. Liouville's theorem. Taylor's and Laurent's theorem. Singular points. Residue, Cauchy's residue theorem.

Vector Analysis: Multiple product of vectors. Linear dependence and independence of vectors. Differentiation and integration of vectors together with elementary applications. Line, surface and volume integrals. Gradient of a scalar function. Divergence and curl of a vector function. Various formulae. Integral forms of gradient, divergence and curl. Green's theorem, Gauss's divergence theorem and Stokes' theorem.

Level-1, Term-2
MATH 257 (Ordinary and Partial Differential Equations)
3.00 Credit Hours

Ordinary Differential Equations: Degree and order of ordinary differential equations. Formation of differential equations. Solution of first order differential equations by various methods. Solution of general linear equations of second and higher order with constant coefficients. Solution of homogeneous linear equations. Solution of differential equations of higher order when dependent and independent variables are absent. Solution of differential equations by the method based on factorization of operators. Fröbenius method.

Partial Differential Equations: Introduction. Solutions of linear and nonlinear partial differential equations of first order. Linear equations of higher order. Equations of the second order with variable coefficients. Wave equations. Particular solutions with boundary and initial conditions.

Level-2, Term-1
MATH 259 (Linear Algebra)
3.00 Credit Hours

Definition of matrices. Algebra of matrices. Transpose of a matrix and inverse of a matrix. Factorization. Determinants. Quadratic forms. Matrix polynomials. Eigenvalues and eigenvectors. Diagonalization.

Introduction to systems of linear equations. Gaussian elimination. Euclidean n-space. Linear transformations from $\mathbb{R}^n$ to $\mathbb{R}^m$. Properties of' linear transformations from $\mathbb{R}^n$ to $\mathbb{R}^m$. Real vector spaces and subspaces. Basis and Dimension. Row space, column space and null space. Rank and Nullity. Inner products. Angle and orthogonality in inner product spaces. Orthogonal basis: Gram-Schmidt process and QR-Decomposition. Linear transformations: Kernel and Range. Application to Computed Tomography and electric networks.

Level-2, Term-2
MATH 357 (Probability and Statistics)
3.00 Credit Hours

Introduction. Sets and probability. Random variables. Properties describing distributions. Treatment of grouped sample data. Some discrete probability distributions. Normal distribution. Sampling theory. Estimation theory. Tests of hypotheses. Regression and correlation. Analysis of variance.

For the Department of Mechanical Engineering

Level-1, Term-1
MATH 161 (Differential Calculus, Solid Geometry and Vectors)
4.00 Credit Hours

Differential Calculus: Differentiation of explicit and implicit functions and parametric equations. Successive differentiation of various types of functions, Leibnitz's theorem. Rolle's theorem, Mean value theorem. Taylor's theorem in finite and infinite forms. Maclaurin's theorem in finite and infinite forms. Lagrange's form of remainders. Cauchy's form of remainders. Expansion of functions. Evaluation of indeterminate forms by L'Hospital's rule. Partial differentiation. Euler's theorem. Tangent and Normal. Subtangent and subnormal in Cartesian and polar co-ordinates. Determination of Maximum and minimum values of functions.

Points of inflexion. Applications. Curvature, radius of curvature, center of curvature and chord of curvature. Evolute and involute. Asymptotes. Envelopes. Curve tracing.

Solid Geometry: System of co-ordinates. Distance between two points. Section formula. Projections, Direction Cosines. Equations of planes and lines.

Vectors: Definition of vectors, equality of vectors. Addition and multiplication of vectors. Triple products and multiple products, application to geometry and mechanics. Linear dependence and independence of vectors.

Level-1, Term-2

MATH 163 (Integral Calculus and Differential Equations)
4.00 Credit Hours

Integral Calculus: Definitions of integrations, integration by the method of substitution, integration by parts, standard integrals, integration by the method of successive reduction. Definite integrals, its properties and use in summing series. Walli's formulae. Improper integrals, Beta function and Gamma function. Area under a plane curve in Cartesian and polar coordinates, area of the region enclosed by two curves in Cartesian and polar coordinates, trapezoidal rule, Simpson's rule. Arc lengths of curves in Cartesian and polar coordinates, parametric and pedal equations, intrinsic equation. Volumes of solids of revolution, volume of hollow solids of revolution by shell method, area of surface of revolution. Convergence and divergence of infinite series.

Ordinary Differential Equations: Formation of differential equations, solution of first order differential equations by various methods. Solutions of general linear equations of second and higher order with constant coefficients. Solutions of homogeneous linear equations, applications. Solutions of differential equations of higher order when the dependent and independent variables are absent. Solution of differential equations by the method based on the factorization of operators.

Level-2, Term-1

MATH 261 (Vector Calculus, Matrices, Laplace Transforms and Series Solution)
4.00 Credit Hours

Vector Calculus: Differentiation and integration of vectors together with elementary applications. Line, surface and volume integrals. Gradient of scalar functions. Divergence and curl of vector functions. Physical significance of gradient, divergence and curl. Stokes' theorem, Green's theorem, Gauss's theorem and their applications.

Matrices: Types of matrices and algebraic properties. Rank and elementary transformations of matrices. Solution of linear equations using matrix. Linear dependence and independence of vectors. Quadratic forms. Matrix polynomials. Determination of characteristic roots and vectors.

Laplace Transforms: Definition of Laplace transform. Elementary transformation and properties. Convolution theorem. Solution of differential equations by Laplace transforms. Evaluation of integrals by Laplace transforms.

Series Solution: Solution of differential equations in series by the method of Fröbenius. Bessel's functions, Legendre's polynomials and their properties.

Level-2, Term-2

MATH 263 (Complex Variables, Harmonic Analysis and Partial Differential Equations)
4.00 Credit Hours

Complex Variables: Complex number system. General functions of complex variables. Limits and continuity of functions of complex variables and related theorems. Complex differentiation and the Cauchy-Riemann equations. Mapping by elementary functions. Line integral of complex functions. Cauchy's integral

theorem. Cauchy's integral formula. Liouville's theorem. Taylor's and Laurent's theorem. Singular points. Residues and Cauchy's residue theorem. Evaluation of residues. Contour integration. Conformal mapping.

Fourier Series: Real and complex form of Fourier series. Finite Fourier transform. Fourier integrals. Fourier transforms and their uses in solving boundary value problems.

Harmonic Functions: Definition of harmonics. Laplace's equation in Cartesian, polar, cylindrical and spherical coordinates. Solution of these equations together with applications. Gravitational potential due to a ring. Steady-state temperature. Potential inside or outside a sphere. Properties of harmonic functions.

Partial Differential Equations: Introduction. Solutions of linear and non-linear differential equations of first order. Linear equations of higher order. Equations of the second order with variable coefficients.

For the Department of Materials and Metallurgical Engineering

Level-1, Term-1

MATH 171 (Calculus and Ordinary Differential Equations)
3.00 Credit Hours

Differential Calculus: Limits, continuity and differentiability. Successive differentiation, Leibnitz's theorem. Partial differentiation, Euler's theorem. Tangent and normal. Maxima and minima.

Integral Calculus: Integration by substitution. Integration by parts. Standard integrals, Definite integrals and their properties. Area under plane curves in Cartesian and polar coordinates. Surface area and volumes of solids of revolution.

Ordinary Differential Equations: Definition. Formation of differential equations. Solution of first order differential equations by various methods. Solutions of differential equations of first order and higher degree. Solutions of linear differential equations of second and higher order with constant coefficient. Solution of homogeneous linear differential equations.

Level-1, Term-2

MATH 175 (Partial Differential Equations and Vector Analysis)
3.00 Credit Hours

Partial Differential Equations: Introduction. Solutions of linear and nonlinear partial differential equations of first order. Linear equations of higher order. Equations of the second order with variable coefficients.

Vector Analysis: Multiple product of vectors. Linear dependence and independence of vectors. Differentiation and integration of vectors together with elementary applications. Line, surface and volume integrals. Gradient, divergence and curl. Various formulae. Integral forms of gradient, divergence and curl. Gauss's divergence theorem, Stokes' theorem and Green's theorem.

Level-2, Term-1

MATH 273 (Matrices, Series Solutions and Fourier Analysis)
3.00 Credit Hours

Matrices: Definition of matrix. Different types of matrices. Algebra of matrices. Adjoint and inverse of a matrix. Rank and elementary transformations of matrices. Normal and canonical forms. Solution of linear equations. Quadratic forms. Matrix polynomials. Cayley-Hamilton theorem. Eigenvalues and eigenvectors.

Series Solutions: Solution of differential equations in series by the method of Fröbenius. Bessel's functions, Legendre's polynomials and their properties.

Fourier Analysis: Real and complex form of Fourier series. Finite Fourier transform. Fourier integrals. Fourier transforms and their uses in solving boundary value problems.

Level-2, Term-2
MATH 275 (Probability and Statistics)
3.00 Credit Hours

Introduction. Sets and probability. Random Variables. Properties describing distributions. Treatment of grouped sample data. Some discrete probability distributions. Normal distributions. Sampling theory. Estimation theory. Tests of hypotheses. Regression and correlation. Analysis of variance.

For the Department of Naval Architecture and Marine Engineering

Level-1, Term-1
MATH 181 (Differential Calculus and Integral Calculus)
3.00 Credit Hours

Differential Calculus: Limits, continuity and differentiability. Differentiation of explicit and implicit functions and parametric equations. Differentials. Successive differentiation of various types of functions. Leibnitz's theorem. Rolle's theorem. Mean Value theorem. Taylor's theorem. Maclaurin's theorem. Lagrange's form of remainders. Cauchy's form of remainder. Expansion of functions by differentiation and integration. Evaluation of indeterminate forms by L'Hospitals rule. Equation of tangent and normal. Partial differentiation. Euler's theorem. Maxima and Minima of functions of single variable. Curvature and circle of curvature. Asymptotes.

Integral Calculus: Integration by parts. Standard integrals. Integration by the method of successive reduction. Definite integrals with properties. Improper integrals. Beta function and Gamma Function. Area. Arc lengths of curves in Cartesian and polar co-ordinates. Volumes of solid of revolution. Area of surface of revolution.

Level-1, Term-2
MATH 183 (Co-ordinate Geometry and Ordinary Differential Equations)
3.00 Credit Hours

Co-ordinate Geometry: Change of axes, Transformation of co-ordinates, Pair of straight lines, System of circles, Co-axial system of circles and limiting points, Equations of parabola, Ellipse and hyperbola in Cartesian and polar co-ordinates, Tangents and normals, Pair of tangents, Chord of contact, Chord in terms of its middle point, Parametric co-ordinates, Diameters, Conjugate diameters and their properties.

Ordinary Differential Equations: Degree and order of ordinary differential equations, Formation of differential equations, Solutions of first order differential equations by various methods, Solution of general linear equations of second and higher order with constant co-efficients, Solutions of homogeneous linear equations of higher order when the dependent and independent variables are absent, Solution of Euler's linear homogeneous equation, Solution of differential equations by the method based on factorization of operators.

Level-2, Term-1
MATH 281 (Vector Analysis and Differential Equations (Special Types))
3.00 Credit Hours

Vector Analysis: Scalars and vectors, Equality of vectors, Addition and subtraction of vectors, Multiplication of vectors by scalars, Position vector of a point, Resolution of vectors, Scalar and vector product of two vectors and their geometrical interpretation, Triple products and multiple products, Application

to geometry and mechanics, Linear dependence and independence of vectors, Differentiation and integration of vectors together with elementary applications, Definition of line, surface and volume integrals, Gradient, Divergence and Curl of point functions, various formulae, Gauss's theorem, Stokes' theorem, Green's theorem and their applications.

Differential Equations (Special Types): Solution of differential equations of higher order when dependent and independent variables are absent, Solution of homogeneous differential equations, Solution of differential equation by the method based on factorization of operators, Solution of differential equations in series by the method of Fröbenius, Bessel's functions, Legendre's polynomials and their properties.

Level-2, Term-2

MATH 283 (Statistics, Partial Differential Equations and Matrices)
3.00 Credit Hours

Statistics: Frequency distribution, Mean, median, mode and other measures of central tendency, Standard deviation and other measures of dispersion, Moments, Skewness and Kurtosis, Elementary probability theory and discontinuous probability distribution, e.g. binomial, Poisson and negative binomial, Continuous probability distributions, e.g. normal and exponential, Characteristics of distributions, Elementary sampling theory, Estimation, Hypothesis testing and regression analysis.

Partial Differential Equations: Introduction, Equations of the linear and non-linear first order, Standard forms, Linear equations of higher order, Equations of the second order with variable co-efficients.

Matrices: Definition of matrix, Different types of matrices, Algebra of matrices, Adjoint and inverse of a matrix, Rank and elementary transformations of matrices, Normal and canonical forms, Solution of linear equations, Quadratic forms, Matrix polynomials, Cayley-Hamilton theorem, Eigenvalues and eigenvectors.

Level-3, Term-2

MATH 381 (Fourier Analysis, Harmonic Functions,Complex Variable and Laplace Transforms)
4.00 Credit Hours

Fourier Analysis: Real and complex form of Fourier series. Finite transform, Fourier integral, Fourier transforms and their uses in solving boundary value problems.

Harmonic Functions: Definition of harmonics, Laplace equation in Cartesian, polar, cylindrical and spherical co-ordinates, Solutions of these equations together with applications, Gravitational potential due to a ring, Steady-state temperature, Potential inside or outside of a sphere, Properties of harmonic functions.

Complex Variable: Complex number system, General functions of a complex variable, Limits and continuity of a function of complex variables and related theorems, Complex differentiation and the Cauchy-Riemann equations, Mapping by elementary functions, Line integral of a complex function, Cauchy's integral theorem, Cauchy's integral formula, Liouville's theorem, Taylor's and Laurent's theorem, Singular points, Residue, Cauchy's residue theorem, Evaluation of residues, Contour integration, Conformal mapping.

Laplace Transforms: Definition of Laplace transform, Elementary transformation and properties, Convolution, Solution of differential equations by Laplace transforms, Evaluation of integrals by Laplace transforms.

For the Department of Industrial and Production Engineering

Level-1, Term-1
MATH 191 (Differential and Integral Calculus)
4.00 Credit Hours

Differential Calculus: Limits, continuity and differentiability, differentiation of explicit and implicit functions and parametric equations, differentials, Successive differentiation of various types of functions, Leibniz's theorem, Rolle's theorem and Mean Value theorem, Taylor's theorem in finite and infinite forms, Maclaurin's theorem in finite and infinite forms, L'Hospital's rule. Tangent and normal, Subtangent and subnormal in Cartesian and polar coordinates, partial differentiation, Euler's theorem, maxima and minima for functions, points of inflection, applications, curvature, evolutes and involutes, asymptotes, envelopes, curve tracing.

Integral Calculus: Integration by parts, integration by the method of substitutions, standard integrals, integration by the method of successive reduction, definite integrals, its properties and uses, Walli's formula, improper integrals, Beta function and Gamma function, area under plane curves in Cartesian and polar coordinates, area of the region enclosed by two cures in Cartesian and polar coordinates, arc-lengths of curves in Cartesian and polar coordinates, parametric, pedal and intrinsic equations, volume of solids of revolution, volume of hollow solids of revolution by shell method, area of surface of revolution.

Level-1, Term-2
MATH 193 (Vector, Matrix and Solid Geometry)
4.00 Credit Hours

Vectors: Definition of vectors, equality of vectors, addition, subtraction and multiplication of vectors, scalar and vector product of two vectors and their geometrical interpretation, triple products and multiple products and their application to geometry and mechanics, linear dependence and independence of vectors.

Matrix: Definition of matrix, different types of matrices, algebra of matrices, adjoint and inverse of a matrix, rank and elementary transformations of matrices, normal and canonical forms, solution of linear equations, quadratic forms, matrix polynomials, Eigen values and Eigen vectors.

Solid Geometry: Transformation of co-ordinates and identification of conics, three dimensional co-ordinate system, projection, direction cosines, equations of planes and lines, angle between lines and planes, distance from a point to a plane, coplanar lines, shortest distance between two given straight lines, standard equations of sphere, ellipsoid, hyperboloid of one sheet, hyperboloid of two sheets, tangent planes, normal lines, condition of tangency.

Level-2, Term-1
MATH 291 (Differential Equations, Vector Calculus and Laplace Transforms)
3.00 Credit Hours

Ordinary Differential Equations: Formation of differential equations, solution of first order differential equations by various methods, solution of general linear equations of second and higher order with constant coefficients, solution in series by Fröbenius method, Bessel's functions, Legendre's polynomials and their properties.

Vector Calculus: Differentiation and integration of vectors together with elementary applications, line, surface and volume integrals, gradient of a scalar function, divergence and curt of a vector function, physical significance of gradient, divergence and curt, Gauss's theorem, Stokes' theorem, Green's theorem and their applications.

Laplace Transforms: Definition of Laplace transform, elementary transformations and properties, convolution, solution of differential equations by Laplace transform, evaluation of improper integrals by Laplace transforms.

8. APPENDICES

Reference Books

Calculus

1. Calculus *by* Howard Anton, Irl Bivens and Stephen Davis.
2. Calculus with Analytic Geometry by Earl William Swokowski.
3. Integral Calculus with Applications by A. K. Hazra.
4. Schaum's Outline of Calculus by Frank Ayres and Elliott Mendelson.
5. Differential and Integral Calculus by B. C. Das and B. N. Mukherjee.
6. Differential Calculus by P. N. Chatterjee.
7. A Text Book on Differential Calculus by Khosh Mohammad and P. K. Bhattacharjee.
8. Precalculus by Michael Sullivan.

Coordinate Geometry

1. The elements of coordinate geometry by S. L. Loney.
2. Two Dimensional Coordinate Geometry by Mohammad Isa.
3. Elements of Coordinate Geometry by Kazi Md. Zahiruddin.
4. Solid Geometry: Analytical Geometry of Three Dimensions by Qazi Zameeruddin and Vijay K. Khanna.
5. A Text Book on Coordinate Geometry by Rahman & Bhattacharjee.
6. An Elementary Treatise on Coordinate Geometry of Three Dimensions *by* Robert J. T. Bell.
7. Coordinate Geometry by Zameeruddin.
8. Solid Geometry by M.L. Khanna.
9. Simplified Course in Coordinate Geometry by Raisinghania M.D., Saxena H.C., Dass H.K.
10. Coordinate Geometry (2-D and 3-D) by G. C. Sharma.

Differential Equations

1. Differential Equations with Applications by M. M. K. Chowdhury.
2. Differential Equations by Shepley L. Ross.
3. Schaum's Outline of Differential Equations by Richard Bronson and Gabriel Costa.
4. A First Course in Differential Equations with Modeling Applications by Dennis G. Zill.
5. Introduction to Partial Differential Equations and Boundary Value Problems by Rene Dennemeyer.
6. Elements of Partial Differential Equations by Ian Naismith Sneddon.
7. Advanced Engineering Mathematics by Peter V. O'Neil.
8. Advanced Engineering Mathematics by Dean G. Duffy.
9. Ordinary and Partial Differential Equations by M. D. Raisinghania.

Linear Algebra

1. Linear Algebra and Its Applications *by* Gilbert Strang.
2. Elementary Linear Algebra: Applications Version *by* Howard Anton and Chris Rorres.
3. Schaum's Outline of Theory and Problems of Linear Algebra by Seymour Lipschutz and Marc Lars Lipson.
4. Matrices and Linear Transformations by Mohammad Iman Ali.
5. Elementary Linear Algebra with Applications by Bernard Kolman.
6. Schaum's Outline of Theory and Problems of Matrices by Frank Ayres, Jr.

Vector Analysis

1. Advanced Engineering Mathematics by Peter V. O'Neil.
2. Vector Analysis with Applications *by* Md. Ali Ashraf and Md. Abdul Khaleq Hazra.
3. Elementary Linear Algebra: Applications Version *by* Howard Anton and Chris Rorres.
4. Advanced Engineering Mathematics by Erwin Kreyszig, Herbert Kreyszig and Edward J. Norminton.
5. Advanced Engineering Mathematics by Dean G. Duffy.
6. Schaum's Outline of Theory and Problems of Vector Analysis *by* Murray R. Spiegel.
7. Vector Analysis by M. D. Raisinghania.

Special Functions and Series Solution

1. Differential Equations with Applications by M. M. K. Chowdhury.
2. Advanced Engineering Mathematics by Peter V. O'Neil.
3. Advanced Engineering Mathematics by Erwin Kreyszig, Herbert Kreyszig and Edward J. Norminton.
4. Schaum's Outline of Theory and Problems of Advanced Calculus by Robert C. Wrede and Murray R. Spiegel.
5. Differential Equations by Shepley L. Ross.
6. Ordinary and Partial Differential Equations by M. D. Raisinghania.

Complex Variables

1. Complex Variables and Applications by James Ward Brown and Ruel V. Churchill.
2. Schaum's Outline of Theory and Problems of Complex Variables by Murray R. Spiegel.
3. Complex Variables: Harmonic and Analytic Functions by Francis J. Flangian.
4. Advanced Engineering Mathematics by Peter V. O'Neil.
5. Advanced Engineering Mathematics by Dean G. Duffy.

Harmonic Functions

1. Applied Mathematics for Engineers and Physicists by Louis Albert Pipes and Laurence R. Harvill.
2. Advanced Engineering Mathematics by Peter V. O'Neil.
3. Advanced Engineering Mathematics by Erwin Kreyszig, Herbert Kreyszig and Edward J. Norminton.
4. Harmonic Function Theory by Sheldon Axler, Paul Bourdon and Ramey Wade.
5. Advanced Engineering Mathematics by Dean G. Duffy.
6. Advanced Engineering Mathematics by H. K. Dass.

Laplace Transforms

1. Schaum's Outline of Laplace Transforms by Murray R. Spiegel.
2. Operational Mathematics by Ruel Vance Churchill.
3. Advanced Engineering Mathematics by Peter V. O'Neil.
4. Advanced Engineering Mathematics by Erwin Kreyszig, Herbert Kreyszig and Edward J. Norminton.
5. Advanced Engineering Mathematics by Alan Jeffrey.
6. Advanced Engineering Mathematics by H. K. Dass.

Fourier Series

1. Fourier Series and Boundary Value Problems by Ruel V. Churchill and James Ward Brown.
2. Schaum's Outline of Fourier Analysis with Applications to Boundary Value Problems by Murray R. Spiegel.
3. Advanced Engineering Mathematics by Peter V. O'Neil.
4. Fourier Series by Ian Naismith Sneddon.
5. Advanced Engineering Mathematics by Alan Jeffrey.
6. Advanced Engineering Mathematics by Dean G. Duffy.

Numerical Analysis

1. Numerical Methods for Mathematics, Science and Engineering by John H. Mathews.
2. An Introduction to Numerical Analysis by Kendall E. Atkinson.
3. Numerical Analysis by Richard L. Burden and J. Douglas Faires.
4. Numerical Methods for Engineers by Steven C. Chapra and Raymond P. Canale.
5. Introductory Methods of Numerical Analysis by S. S. Sastry.
6. Advanced Engineering Mathematics by Alan Jeffrey.

Statistics

1. An Introduction to Statistics and Probability by M. Nurul Islam.
2. Probability and Statistics for Engineers and Scientists by Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers and Keying Ye.
3. Probability and Statistics for Engineers by Irwin Miller and John E. Freund.
4. Probability and Statistics with Applications by Y. Leon Maksoudian.
5. Elements of Probability and Statistics by Frank Louis Wolf.

Basis for awarding marks for class participation and attendance will be as follows:

	Attendance	**Marks**
90% and above		10
85% to less than	90%	9
80% to less than	85%	8
75% to less than	80%	7
70% to less than	75%	6
65% to less than	70%	5
60% to less than	65%	4
Less than	60%	0

For 2 credit courses 3 best out of 5, for 3 credit courses 4 best out of 6, and for 4 credit courses 5 best out of 7 quizzes may by considered for awarding grade. These may be considered as the minimum recommended number of quizzes for any course. If the number of quizzes administered in a course exceeds these minimum numbers, than two-thirds best of all quizzes may be considered. The scheme of continuous assessment that a teacher proposes to follow for a course will be announced on the first day of classes.

9. Course system (Under Graduate)

Numerical grade	Letter grade	Grade point
80% or above	A^+ (A plus)	4
75% to less than 80%	A (A regular)	3.75
70% to less than 75%	A^- (A minus)	3.50
65% to less than 70%	B^+ (B plus)	3.25
60% to less than 65%	B (B regular)	3.00
55% to less than 60%	B^- (B minus)	2.75
50% to less than 55%	C^+ (C plus)	2.50
45% to less than 50%	C (C regular)	2.25
40% to less than 45%	D	2.00
Less than 40	F	0.00
Continuation (for project & thesis design courses)	X	

১৮/০৩/৯৩ইং তারিখে কোর্স পদ্ধতি মনিটরিং কমিটির সভায় কোর্স পদ্ধতির নিম্নলিখিত সিদ্ধান্তটি গৃহীত হয়।

***** Total Marks হইতে Percentage Marks-এ convert করার সময় Round of করার জন্য 0.5 and above কোর্স সংখ্যা next higher whole number-এ পরিবর্তন হবে and less than 0.5 previous whole number থাকবে। (যেমন 8.5% হইতে 59%, 58.49% হবে 58%)

Rules and Regulations for Course System (Vide A/C Resolution dated 14/3/96)

Article : 12 (Earned Credit)

* When a student will repeat a course in which he/she previously obtained a "**F**" grade, he/she will not be eligible to get a grade better than "**C**" in such a course.

* If a students obtains "**D**" grade in a course, he/she will be allowed to repeat the course for the purpose of grade improvement by forgoing his/her earlier grade, but he/she will not be eligible to get a grade better then "**C**" in such a course.

10. Syllabus for Postgraduate Program
Department of Mathematics

Math 6101 (Special function and integral transforms-I)
3.00 Credit Hours

Gamma and Beta Functions: Properties of Gamma function, Continuity and convergence of gamma and beta functions, integral form of Γn . Asymptotic representation of Gamma function for Large $|n|$.

Elliptic Integral and Elliptic Functions: Reduction of elliptic integrals to standard form, properties of elliptic function addition formulae, periods of elliptic function.

The probability integral and related functions; application to the theory of heat conduction and to the theory of vibration. Generating function of the Hermite and Laguerre polynomials, recurrence relations, the differential equation and the integral equation satisfied by the polynomials. Integral representations, orthogonality and Laguerre polynomials Hypergoemetric functions its linear and quadratic transformations. The confluent hypergeometric function, its integral and asymptotic representation. Representation of various functions in terms of hypergeometric and the confluient hypergeometric functions. Hermite functions. Matheus functions and the Dirac Delta functions. The Minkowski Temple. Theory of generalized function. Schwartz's theory of distribution.

Math 6102 (Special function and integral transforms-II)
3.00 Credit Hours

Green's function and its applications. Fourier integral theorem and Fourier transforms. Multiple fourier transforms. Fourier transforms of radially symmetric functions. The solutions of integral equations

of convolution type. Use of Fourier transforms in solving Laplace's equation, diffusion equations and wave equations. The double Laplace transform, the iterated Laplace transform, the Stieltjes transform and the Hankel transform. The Perseval relation for Hankel transform and the relation between Fourier and Hankel transforms. Use of Hankel transforms in solving partial differential equations.

Math 6103: Advanced Modern Algebra

3.00 Credit Hours

Rings, fields, polynomials, homomorphisms, ideals, quotient rings. Ring extensions, field extensions, construction of finite fields. Integral domains, euclidean rings, polynomial rings, principal ideal domains and unique factorization domains. Chain conditions. Modules, submodules, finitely generated modules, direct sums, quotient modules and isomorphism theorems. Torsion, bases and free modules, free modules over polynomial rings. Invariant factors, structure of finitely generated modules.

Math 6104: Rings and Modules

3.00 Credit Hours

Artinian and Noetherian modules. Categories and functors, exactness of functors between module categories. Injective and projective modules. Semisimple modules and rings. Radical and socle. The tensor product, flat modules and regular rings. The ring of fractions, orders in a semisimple ring, modules of fractions. Application of rings and modules to abelian groups, to vector spaces with a linear transformation, to languages, grammars, machines, coding theory, etc.

Math 6105: Numerical Linear Algebra

3.00 Credit Hours

Summary of basic concepts from linear algebra and numerical implementation. Cholesky factorization. QR decomposition by Householder matrices and by given rotations. LU factorization and partial pivoting. Error analysis. Solving triangular systems and full systems. LU factorization for banded and sparse matrices. Storage schemes. SOR iterations. Krylov subspace methods and conjugate gradient method. Preconditioning. Basic theory using singular value decomposition (SVD). Perturbation theory. SVD and rank deficiency. Basic theory including perturbation results. Power method, inverse iteration. Similarity reduction. Solving nonlinear system of equations by finite-difference and modified Newton methods. Symmetric QR algorithm. Interpretation as a matrix factorization. Application to solving circulant systems. p-adic numbers, ring of p-adic integers, field of p-adic numbers, field of fractions of p-adic numbers, p-adic topology, cyclomatic field, Local field, Tate module. Solution of Diophantine equations. Mahler-Lech theorem. Valuation theory and Staudt-Clausen theorem. Local-global principle.

Math 6201 (Fluid Dynamics - I)
3.00 Credit Hours

Eulerian and Lagrangian method of description of fluid; Analytic approach of deformations; Derivation of equations of conservation of mass. Momentum and energy. Basic equations in different coordinate system, boundary conditions. Irrotational and rotational flows. Bernoulli's equation and some applications. Two dimensional irrotational incompressible flows with circulation; sources and sinks; Vortex motion. Combination of basic flows, mapping of flows in complex coordinates. Aerofoil theory, Schwartz-Christorel theory, Navier-Stokes' equations. Gravity

waves, One dimensional compressible flows sound waves, Shock waves; Two dimensional irrotational flows. Hypersonic flows; Viscous compressible fluid flows. Incompressible fluid flow between two parallel plates; flow through a circular pipe and annulus. Flow between a plane and a cone; Flow through convergent and divergent channel flow in the vicinity of a stagnation point; Unsteady flows.

Math 6202 (Fluid Dynamics - II)
3.00 Credit Hours

Small Raynold's number flows; flows over a sphere; flow over a cylinder through porous media Lubrication theory. Boundary layer theory; properties of Navier-Stokes equations; two dimensional boundary equations; displacement, momentum and energy thickness for two dimensional flows. Von Mises transformation. Similarity solutions of boundary layer equations. Boundary layer flow over a flat plate, boundary layer flow with pressure gradient; Approximate solutions of boundary layer equations, including Von-karman's method. Stability theory; Basic concepts of stability theory; Stability of Quett's flow; Stability of low between two parallel plates Rayleigh. Taylor instability; Kelvin-Helmholtz instability.

Turbulence: Reynolds stresses and basic equation for turbulent flows; Prandtl mixing length theory; some simple turbulent flows; homogeneous turbulence; spectral theory of homogeneous turbulence. Non Newtonian fluid flows; Riener-Rivlin fluids; power law fluids; flows in ells fluids; flow in Binghan plastics Visco-Elastic flows general visco elastic fluid flows.

Math 6203: Computational Fluid Dynamics and Heat Transfer-I
3.00 Credit Hours

Introduction to computational Fluid Dynamics (CFD) and Heat Transfer, Basics of the methods used in CFD and Heat Transfer,

Conversion equations (mass, momentum, energy and chemical species), Finite difference and Finite Volume Methods, Grid Generation, space and time discretization schemes, Tri-diagonal Matrix Algorithm (TDMA), Data Analysis, Data Fusion and Post Processing, The Role of Experimental data in CFD and Heat Transfer.

Math 6204: Computational Fluid Dynamics and Heat Transfer-II
3.00 Credit Hours

Review on the physical properties of fluid flow and heat transfer, Coupling of flow and heat transfer; computational methods for coupled equations with appropriate boundary conditions. Conjugate heat transfer and combination of different modes of heat transfer, i.e., conduction, convection and radiation. Correlations for natural, forced and mixed convection governing equations, dimensionless parameters, optical thickness for radiative heat transfer, black- and gray-body radiation, different models for radiative heat transfer, Computation of coupled flow and heat transfer equations using Finite difference methods, Mesh generation. Triangular tetrahedral and brick meshing, Galerkin Weighted Residual method.

Math 6205: Finite Element Analysis on Heat and Mass Transfer
3.00 Credit Hours

Overview of finite element method, Discretization of a domain, the concept of element, various element shapes. Weak form formulation: Weighted Residuals, Galerkin method. Heat functions, Generalized matrix form of the Finite element equations, Shape functions, Integration, 2-D numerical integration, Different types of heat transfer, Overall heat transfer, Different types of mass transfer, Mass transfer theories. Overall mass transfer, Heat conduction and mass diffusion, Heat sources, Convective heat and

mass transfer, Finite element formulation of the convection-diffusion equation, Computer implementation, Numerical solution of finite element equations, One dimensional and two-dimensional problems, Basic equations of fluid mechanics, Computational modelling, FEM for heat and mass transfer problems.

Math 6206: Mathematical Hydrology

3.00 Credit Hours

Hydrologic model system. Hydrologic model classification. Development of hydrology. Continuity equation. Discrete time continuity, Momentum equation. Open channel flow, Porous medium flow, Water balances. Precipitation. Evaporation and transpiration. Infiltration and soil moisture, Green-Ampt method. Hydrologic cycle, Groundwater in hydrologic cycle. Rainfall runoff relations: Sources of stream flow, Excess rainfall and Direct runoff. Abstraction using infiltration equation, SCS method for abstraction, Index method. Traveltime, Streamflow hydrographs, Unit hydrograph methods and their applications, Synthetic and instantaneous unit hydrographs and their applications. Flood routing: Basic equations, Reservoir flood routing, River flood routing, Lumped flow routing, Distributed flow routing. Frequency analysis: Rational method, Empirical formulae, Return period. Extreme value distributions, Frequency analysis using frequency factors. Linear channels. Conceptual and Mathematical Models: (i) Nash model, (ii) Time-area method (iii) Clark's model (iv) Dooge's model, (v) Chow and Kulandaiswamy model, (vi) Muskingum model. Hydrodynamic Models: (i) Saint-Venant Equations from Navier-Stokes' equation, (ii) Kinematic wave models, (iii) Diffusion wave models, (iv) Steady dynamic wave models, (v) Dynamic wave models. (vi) Gravity wave models. Flood Forecasting.

Math 6207: Thermodynamics and Statistical Mechanics

3.00 Credit Hours

Equations of State. Work, Coefficients of expansion and compressibility. The first law of thermodynamics and its application. Changes of phase. The Second law of Thermodynamics, Efficiencies of reversible engines. The Clausius-Clapeyron equations, Stefan's law entropy, Combined applications of the first and second law. Kinetic theory of an ideal gas. The distributions of molecular velocities, Mean free path, Coefficient of viscosity. Thermal conductivity, Coefficient of diffusion. The Maxwell-Boltzamann Statistics. Quantum theory of specific heats. Elements of Fermi-Dirac statistics and Bose-Einstein statistics.

Math 6208: Electrodynamics

3.00 Credit Hours

Equation of continuity. Displacement current, The Maxwell's equations and their differential forms, Maxwell's equation in free space, Energy in electromagnetic fields. Poynting's theorem. Electromagnetic waves in free space; Energy flow due to plane electromagnetic waves; plane electromagnetic waves in matter, isotropic dielectric, anisotropic dielectric, anti in conducting media; polarization of electromagnetic waves. Boundary conditions for the electromagnetic field vectors, S.E.D and H at the interface between two media; Reflection and refraction at the boundary of two non-conducting madia; General treatment of reflection and refraction-Fresnel's equations; Scattering by free electrons, Scattering by a bound electron. Electromagnetic potentials, Non-uniqueness of electromagnetic potentials and gauge transformation; Coulomb gauge, solution of inhomogeneous wave equations, Retarded and advanced potentials; solution of inhomogeneous wave equation by Fourier analysis. Electromagnetic potentials in uniform electric and magnetic fields.

Domains of magneto-hydrodynamics and plasma physics; Electrica1 neutrality in a plasma, Debye screening; Magneto-hydrodynamic equations, plasma oscillations and Alfeen waves.

Math 6301 (Similarity Analysis)
3.00 Credit Hours

Principle and illustrations of dimensional analysis, systematic calculation of dimensionless products, algebraic theory of dimensional analysis, different procedures, (Rayleigh; Buckingham pie-theorem, stepwise, echelon, propertionalities etc.) for the determination of dimensionless groups and its behaviour for some boundary value problems; Method of similude and introduction to fractional analysis of overall equations, a free parameter method for similarity solution applied to two dimensional boundary layer flows, method of separation of variables, similarity requirements for three dimensional. Axisymmetric velocity and thermal boundary layer laminar flows (both steady and unsteady), group theory method, absorption of parameters and natural co-ordinates in similarity variables, reduction of independent variables, similarity and natural co-ordinates on linearised compressible flow, supersonic and transonic similarity rules. Karman similarity criteria for turbulent shear layers.

Math 6302 (Perturbation and Approximation Theory)
3.00 Credit Hours

The nature of perturbation theory, some regular perturbation problems, the technique of perturbation theory, some singular perturbation in sirofoil theory, the method of matched asymptotic expansion, the method of strained co-ordinates in viscous flow at high Roynolds number, some inviscid single perturbation problems, aspect of perturbation theory. New classes of information by approximation theory, classification of problems

and difficulties in approximation theory, analysis of the condition for approximation theory.

Math 6401 (Optimization Techniques - I)
3.00 Credit Hours

Introduction. Classical methods with single and multivariables. Linear programming, Graphical method with mathematical definitions and theorems; Solution of a system of linear simultaneous equations, Pivotal reduction of a general system of equations simples method with theoretical development. Transportation problem. Non linear programming: One dimensional problems by elimination and interpolation methods; Unconstrained techniques, direct search and descent methods; constrained techniques and indirect methods.

Math 6402 (Optimization Techniques - II)
3.00 Credit Hours

Geometrical programming, Dynamic programming; Stochastic programming; Game theory; CPM and PERT; Calculus of variations.

Math 6403: Integer Programming
3.00 Credit Hours

Basics of Mathematical Programming. Valid Inequalities and Faces of Polyhedra. Dimension. Extreme Points. Facets. Minkowski's Theorem. Most IPs are Linear Programs. Equivalent Definitions of Integrality. Matchings and Integral Polyhedra. Total Unimodularity. Conditions for Total Unimodularity. Applications of Unimodularity. Network Flows. Matchings and Integral Polyhedra. Total Dual Integrality. Submodularity and Matroids. Encoding Schemes. Problems and Instances. The Classes P and

NP. The Complexity of Integer Programming. Optimality and Relaxation, Combinatorial Relaxations. Lagrangian Relaxation. Knapsack Problem. Problems on Trees. Branch and Bound Algorithm. Cutting-Plane Algorithms. Gomory's Cutting-Plane Algorithm. Mixed Integer Cuts. Structured Inequalities. Convexity and Subgradient Optimization. Subgradient Optimization for the Lagrangian Dual.

Math 6404: Logistics Management

3.00 Credit Hours

Introduction to Logistics Management. Logistics Network Configuration. Transportation Rates. Warehousing Cost. Capacity and Location Demand Forecast. Inventory Management and Risk Pooling. Distribution Strategies. Strategies Alliances. Global Issues. Coordination Product and Supply Chain Design. Vendor and Buyer System. Vendor-Managed Inventory. Coordination Policies. Firms Location Strategies and Choice Model.

Math 6501 (Quantum Mechanics)
3.00 Credit Hours

Old quantum theory and its background. Wave particle duality. Wave packets in space and time. The Schrodinger wave equation. Solution of Schrodinger wave equation (Bound states). The hydrogen atom. Separation of the wave equation in different coordinate system. The orbital angular momentum. Solution of Schrodinger wave equation (Collision theory): Scattering amplitude and differential cross section. Matrix formulation of Quantum Mechanics: Angular momentum matrices. Combination of angular momentum states, Clebsch-Gordan coefficients. Approximation methods: Stationary and time dependent perturbation theory. The variation method, The WKB approximation. Adiabatic and sudden approximation. The scattering matrix and Green's

function technique. Symmetry properties of S-matrix. Transition matrix and scattering cross-section. The Born approximation method. Identical particles: Bosons and Fermions. Collision of identical particles.

Math 6502 (Relativistic Quantum Mechanics)
3.00 Credit Hours

Basics of special theory of relativity. Formulation of a relativistic quantum theory. Klein-Gordon equation. The Dirac equation. The spin of a Dirac particle. Lorentz transformation and Dirac equation. The Dirac bilinear covariants. Solutions of the Dirac equation for a free particle. Projection operators for energy and spin. Physical interpretation of free particle solutions. Interactions in Dirac theory: Hydrogen atom and fine structure of its energy levels. Dirac's hole theory and theory of positrons. Charge conjugation. Propagators for electron and positron. Some applications: Coulomb scattering of electrons. Coulomb scattering of positrons, Electron scattering from a Dirac proton.

Math 6503 (Quantum Field Theory-I)
3.00 Credit Hours

Canonical formalism and Quantization for fields. Symmetries and Conservation laws. The Klein-Gordon Field. Second Quantization of the electromagnatic field. The Feynman Propagator. Interaction with an external field. Symmetry properties of interactions. Symmetries of strange particles. Vacuum expectation values. The S-matrix and Asymptotic Theory. General properties of the S-matrix. Unitarity and partial wave decomposition. Causality and Analylicity. Perturbation theory. Interaction representation and Feynman Rules. Dispersion Relations.

Math 6504 (Quantum Field Theory-II)
3.00 Credit Hours

Regularization and Power counting. Renormalization. Massless theories and Weinberg's theorem. Renormalization in case of Quantum Electrodynamics. Path Intergrals. Trajectores in the Bargmann - Fock space. Relativistic formulation. S-matrix and Green Functions in terms of Path Integrals. Constrained systems: The Electromagnetic Field as an example. Large orders in perturbation theory. Symmetries: Quantum Implementation of Symmetries. Mass spectrum, Multiplets and Goldstone Bosons. Current Algebra and Commutators. Axial Current and Chiral Symmetry. The σ-model and renormalizations. Anomalies: Axial anomaly in the σ-model. Classical theory of non-abelian Gauge fields. Quantization of Gauge Fields. Feynman Rules. Massive Gauge fields. The Weinberg-Salam Model.

Math 6601 (Advanced Matrix Theory)

3.00 Credit Hours

Matrix Operations: Direct sum of matrices, Kronecker product, Jordan product, Lie product, Khatri-Rao product, Vec operation and their properties. Canonical Forms and Matrix Factorization : Jordan canonical form, Smith's canonical form, Full rank factorization, Shur's Triangularization, LU factorization, QR Factorization, Spectral decomposition. Norms and Measures of Matrices.
Matrix calculus: Matrix sequence, series and their convergence. Computation of matrix function by different methods; limit, continuity, differentiation of matrices. Solving ODE using matrix.
Generalized inverse of matrices: Classification and properties. Different methods of computing generalized inverse of matrices: using property, Decell's method, Fedeev-Leverrier's method, Penrose method, Graybill-Meyer-Painter method, Drazin pseudoinverse, Moore-Penrose-Cline inverse, Urquhart computation of various inverses from {1} inverse.

Math 6602 (Nonlinear Dynamical Systems)
3.00 Credit Hours

Carleman Embedding Technique of linearization of ODE, PDE, Difference equation, Algebraic equation. Linearization in a Hilbert space (ODE and PDE). Applications: Bifurcation and Chaos; Symmetries and First integrals of ODE and PDE. Other linearization Techniques: Lie-Koopman linearization, Invertible Point Transformation, Painleve test, the method of turning variables.

MATH 6603: Evolutionary Game Theory

3.0 Credit Hours

Concept in evolutionary game theory. Selection, mutation, and mating. Evolutionarily stable strategies. Replicator dynamics. Cooperative and non-cooperative game. 2-player and 2-strategy games. Dilemma strength and social efficiency deficit. Asymmetric game. Finite and infinite population dynamics. Evolution of cooperation. Three-strategy games. Evolutionary graph theory. Evolutionary game on networks. Mathematical and computational dynamics of evolution in biological and social systems.

MATH 6604: Mathematical Modeling in Epidemiology

3.0 Credit Hours

Mathematical epidemic modeling and properties. Local and global stability analysis. Bifurcation analysis. Techniques of computing reproduction numbers. Deterministic and stochastic modeling. Pair-approximation model. Agent-based model. Network-based model. Models for specific diseases. Multi-strains model. Vector-based model. Age-structured model. Spatial heterogeneity in epidemiological models. Ecological context of epidemiology. Intervention-based behavioral epidemic model. Infectious disease epidemiology and data analysis.

Math 6701 (Partial Differential Equations (PDEs)
3.00 Credit Hours

Classification of PDE (parabolic, elliptic, hyperbolic), Existence, uniqueness and represention of solutions for the PDE (wave equation & heat equation). Cauchy, Dirichlet and Neumann boundary-value problems for the Laplace and Poisson equation. Potential theory in two and higher dimensional domains, initial and boundary value problems of heat equation and wave equation, Maximum principle of parabolic equation; Sturm-Liouville systems, boundary and eigenvalue problems, method of eigenfunction expansions.

Math 6702 (Advanced Numerical Methods-I)
3.00 Credit Hours

Richardson extrapolation of differentiation, Romberg integration, Predictor-corrector methods, Runge-Kutta Methods, Multistep methods (Adam Bashforth-Moulton method, Adams method for initial value problem, Milne-Simpson method); Stability, time stability, stiffness. Hybrid (Gragg and Stetter, Butcher, Nordsieck) and extrapolation (Bulirsch and Stoer) methods for two point boundary value problem, Linear shooting, shooting for nonlinear problems, finite difference methods for linear and nonlinear problems. Systems of ODE, stiffness, A-stability, Gear's method. Finite difference methods for Elliptic, Parabolic & Hyperbolic PDEs.

Math 6703 (Advanced Numerical Methods-II)
3.0 Credit Hour

Pade′ Approximants. Algebraic and Differential Approximants. Approximate Solution of Linear Differential Equations. Approximate Solution of Nonlinear Differential Equations. Asymptotic Expansion of Integrals. Perturbation Series. Summation of Series. WKB Theory. Multiple Scale Analysis. Keller Box methods. MAPLE and MATLAB.

Math 6704 (Numerical Heat Transfer and Fluid Flows)
3.0 Credit Hour

Overview of the Numerical Methods and General Mathematical Framework. The Heat Transfer Equation, Numerical Scheme and its implementation, Grid and Control Volumes. Interface-Related Quantities, General Discretization Equation, Treatment of Boundary Conditions, Calculation of the Boundary Flux, Solution of the Discretization Equations, Nonlinearity and Underrelaxation, Relative Dependent Variable, Treatment of Irregular Geometries, Flow and Heat Transfer in Ducts, Developing and Fully Developed Duct Flows, Mathematical Formulation of the Velocity Field, The Governing Equation, Presentation of the Overall Flow Characteristics, Fully Developed Heat Transfer, Mathematical Formulation of the Temperature Field, Prescribed Local Heat Flux, Axially Uniform Heat Flow and Peripherally Uniform Wall Temperature, Axially and Peripherally Uniform Wall Temperature, Uniform External Heat Transfer Coefficient, Complex Boundary Conditions, Duct Flow Adaptations.

Math 6801 (Graph Theory - I)
3.00 Credit Hours

Graphs and Subgraphs: Graphs and Simple graphs, The Incidence and Adjacency Matrices, Subgraphs, Vertex degrees, Paths and Connection, Cycles. Trees and Forests: Connectivity : Complementary graphs, Cut-vertices and Bridges, Blocks. Construction of Reliable Communication Networks. Euler Tours and Hamilton Cycles : Euler Tours, Hamilton Cycles, The Chinese Postman Problem, The Travelling Saleman problem. Vertex Colourings: Chromatic number, Chromatic Polynomials, Brooks Theorem, A Storage Problem, Edge Colourings: Edge chromatic number, Vizing's theorem, The time tabling problem.

Math 6802 (Graph Theory - II)
3.00 Credit Hours

Matchings, Factorization and coverings: The personal assignment problem. Planar and nonplanar Graphs: Euler's formula, Dual graphs, Characterization of planar graphs, The Five colour theorem and the Four colour conjecture. Non Hamiltonian planar graphs. Independent sets and Cliques: Independent sets, Ramsey's theorem, Turan's theorem, Schur's theorem. Perfect Graphs: Directed Graphs: Directed graphs, Directed paths and cycles, A job sequencing problem. Networks : Flows, Cuts, The Max-flow Min-cut theorem, Manger's theorem. Tournaments: Elementary properties of tournaments, Hamiltonian tournaments, Score sequences.

Math 6803: General and Algebraic Topology
3.00 Credit Hours

Review of basic of general topology. Regular, completely regular and normal spaces. The Urysohn lemma and the Tietze Extension theorem. Convergence in general topology. Nets and filters. Compact and locally compact spaces. The Tychonoff theorem. Para compactness. Uniform spaces. Function spaces. Compact open topology. Stone-Weierstrass theorem. Homotopy theory. Fundamental groups. Simplicial homology. Degree and Lefschetz number. Euler-Poincare formula. Borsuk-Ulam theorem. Brouwer's fixed point theorem.

Math 6804: Lattice Theory
3.00 Credit Hours

Two definitions of lattices. Representation of finite poset by covering relations. Hasse diagrams. Homomorphisms. Isotone maps, ideals, convex sublattice, congruence relations. Congruence

lattices. The homomorphism theorem. Product of lattices, complete lattices, ideal lattices. Distributive-modular inequalities and identities. Complements and pseudo complements. Boolean lattices. Boolean lattice of pseudo-complements in a meet semilattice. Atoms, irreducibility of elements. Characterization theorem for modular and distributive lattices. Dedekind's characterization of modular lattices. Birkhoff's characterization of distributive lattices. Representation of distributive lattices. Stone theorem, Natchbin theorem and Hashimoto's theorem. Distributive lattices with pseudo complementation. Stone lattice and its characterizations. Stone algebra and its characterization. Distributive, standard and neutral elements. Distributive, standard and neutral ideals. Structure theorems.

Math 6805: Fuzzy Mathematical Structures
3.00 Credit Hours

Constructing fuzzy sets, Operations of fuzzy sets, t-and s-norms, α-cuts, Extension principle, Measurement of fuzziness, Fuzzy relations, Fuzzy similarity, Fuzzy ordering, Pattern classification based on fuzzy relations. Fuzzy relational equations. Representation theorems. Interval analysis, Arithmetic operations with applications. Multi-valued logics, Fuzzy propositions, Fuzzy quantifiers, Linguistic hedges, Approximate reasoning. Fuzzy topologies, F-continuous functions, Fuzzy metric spaces, Fuzzy neighborhood spaces, Fuzzy convergence, Compact fuzzy spaces, Fuzzy connectedness, Fuzzy components. Fuzzy substructures of algebraic structures, Fuzzy monoids and automata theory, Fuzzy subgroups and pattern recognition, Free fuzzy monoids and coding theory.

11. Syllabus of Postgraduate Degree

For the Department of Materials and Metallurgical Engineering

Math 6901 PDE, Statistics and Fourier Analysis
3.00 Credit Hours.

Partial Differential Equation: Derivation of one dimensional and two dimensional wave equation and heat equations and their solutions. Solution of boundary value problem by the method of separation of variables. Solution of elliptic, parabolic and hyperbolic equations. Solution of nonlinear PDE. Mong's method. Solution of PDE by finite difference method.

Statistics: Gaussian distribution. Time series analysis, Index numbers, Correlation theory. Multiple and Partial Correlation. Analysis of Variance.

Fourier Analysis: Fourier series, Determination of Fourier coefficient, Fourier sine and cosine series, Half range Fourier series, Change of intervals, Dirichlet's condition, Convergence of Fourier series, Complex form of Fourier series, Perseval's formula, Fourier integral, Fourier transforms and their uses in solving boundary value problems.

For the Department of Naval Architecture and Marine Engineering

Math 6903 Advanced Mathematics
3.00 Credit Hours.

Statistics: The Normal distribution. Correlation and Regression. Coefficient of Correlation. Correlation of time series. Characteristic Movements of time series. Moving averages. Measurement of seasonal variation, Forecasting. Chain Base Method and Cost of living index.

Numerical Analysis: Numerical solution of ordinary differential equation, Taylor series Method, Euler's method, Runge-Kutta method. Accuracy of one step method, multistep method. System of differential equation.

Boundary value and Engineering problems (linear and nonlinear). Shooting method (linear and nonlinear) finite difference method. Solution of applied problems. Solution of partial differential equation — Elliptic, Parabolic, Hyperbolic partial differential equation with special consideration to Heat Equation.

Fourier Analysis: Fourier series expansion for a single variable, Real and complex form, Convergent Fourier series, Calculus of Fourier series, Fourier integral formula and Fourier transforms. Fourier transform and its properties. Convergence of Fourier series, Fourier transforms for single and multivariable. The discrete Fourier transform and properties. Application in solving boundary value problems.

Advanced vector Analysis: Kinematics and Differential Geometry, Elementary theory of surfaces, Metric.

For the Department of Water Resources Engineering

Math 6905 Advanced Mathematics
3.00 Credit Hours.

Fourier Analysis: Fourier series expansion for a single variable, Real and complex form, Convergent Fourier series, Calculus of Fourier series, Fourier integral formula and Fourier transforms. Fourier transform and its properties. Convergence of Fourier series, Fourier transforms for single and multivariable. The discrete Fourier transform and properties. Application in solving boundary value problems.

Statistics: The Normal distribution. Correlation and Regression. Coefficient of Correlation. Correlation of time series. Characteristic Movements of time series. Moving averages. Measurement of seasonal variation, Forecasting. Chain Base Method and Cost of living index.

Numerical Analysis: Numerical solution of ordinary differential equation, Taylor series Method, Euler's method, Runge-Kutta method. Accuracy of one step method, multistep method. System of differential equation.
Boundary value and Engineering problems (linear and nonlinear). Shooting method (linear and nonlinear) finite difference method. Solution of applied problems. Solution of partial differential equation — Elliptic, Parabolic, Hyperbolic partial differential equation with special consideration to Heat Equation.

Advanced vector Analysis: Kinematics and Differential Geometry, Elementary theory of surfaces, Metric.

For the Department of Nanomaterials and Ceramic Engineering

Math 6907: Partial Differential Equations and Integral Transforms 3.00 Credit Hours.

Partial Differential Equation: Derivation of one dimensional and two dimensional wave equations and heat equations and their solutions. Solution of boundary value problem by the method of separation of variables. Solution of elliptic, parabolic and

hyperbolic equations. Solution of nonlinear PDE. Monge's method. Solution of PDE by finite difference method.

Statistics: Gaussian distribution. Time series analysis, Index numbers, Correlation theory. Multiple and Partial Correlation. Analysis of Variance.

Integral Transforms: Fourier series, Fourier integral theorem and Fourier transform. Applications of Fourier integral and Fourier transform in solving Laplace's equation, Diffusion equation and wave equation. The Laplace transform and Hankel transform. Applications of Laplace and Hankel transform in solving boundary value problems.

12. Grading System for Postgraduate

90% and above	A+	4.0
80% - 89%	A	3.5
70% - 79%	B+	3.0
60% - 69%	B	2.5
50% - 59%	C	2.0
50% below	F	0.0
