DEPARTMENT OF MATHEMATICS

Course Book for

Mathematics courses in

B. Arch. / B. Tech.

For

Academic Year
2023 - 2024

Visvesvaraya National Institute of Technology,

Nagpur-440 010 (M.S.)

Institute Vision Statement

To contribute effectively to the National and International endeavor of producing quality human resource of world class standard by developing a sustainable technical education system to meet the changing technological needs of the Country and the World incorporating relevant social concerns and to build an environment to create and propagate innovative technologies for the economic development of the Nation.

Institute Mission Statement

The mission of VNIT is to achieve high standards of excellence in generating and propagating knowledge in engineering and allied disciplines. VNIT is committed to providing an education that combines rigorous academics with joy of discovery. The Institute encourages its community to engage in a dialogue with society to be able to effectively contribute for the betterment of humankind.

Department Vision Statement

- To be a leading Mathematics Department in the country.
- To emerge as a global center of learning, academic excellence, and innovative research.

Department Mission Statement

- Imparting of quality mathematics education and the inculcating of the spirit of research through innovative teaching and research methodologies.
- To achieve high standards of excellence in generating and propagating knowledge in Mathematics. Department is committed to providing an education that combines rigorous academics with joy of discovery.
- To provide an environment where students can learn, become competent users of mathematics, and understand the use of mathematics in other disciplines.

Brief about Department of Mathematics :

The Department of Mathematics VNIT Nagpur grew from its humble beginnings in the year 1960. The Department offers several courses in Mathematics to undergraduate and postgraduate students of various science and engineering disciplines. The Department commenced a two-year Master of Science (M.Sc.) program in Mathematics in 2012. Currently, the department has eleven full-time regular highly qualified, enthusiastic and energetic faculty members. All faculty members of the Department hold a PhD degree in Mathematics, with some of them having postdoctoral experience, from reputed institutes in India or abroad.

List of faculty Members

Sr No	Faculty Name	Areas of specialization
1.	Dr. G. P. Singh	Relativity and Cosmology, Mathematical Modelling
2.	Dr. P. P. Chakravarthy	Numerical Analysis, Numerical Treatment of Singular Perturbation problems and Singularly Perturbed Differential-Difference equations
3.	Dr. Pallavi Mahale	Functional Analysis and Operator equations
4.	Dr. M.Devakar	Fluid Dynamics
5.	Dr. G. Naga Raju	Numerical Techniques for Partial Differential Equations; Spectral/Finite Element Techniques, Finite Volume Method, Parallel Computing
6.	Dr.Pradip Roul	Numerical analysis of singular BVP, Numerical methods for fractional ODE/PDE, Nuclear Reactor dynamics
7.	Dr. Deepesh Kumar Patel	Nonlinear Analysis, Fixed Point Theory
8.	Dr. Jyoti Singh	Commutative Algebra
9.	Dr. Sourav Pradhan	Queueing Theory; Stochastic Modeling
10.	Dr. Vishnu Pratap Singh	Operation research, Optimization under uncertainty
11.	Dr. Vijender Nallapu	Fractal Approximation
12.	Dr. Purnima Satapathy	Lie Groups and Lie Algebra, Partial Differential Equations
13.	Dr. Sourav Bhattacharya	Planar Topology, Dynamical Systems and Ergodic Theory
14.	Dr. Mohan Kumar Mallick	Nonlinear Elliptic PDEs
15.	Dr. NeelimaBhengra	Wave propagation Theory; Theoretical Seismology; Solid Mechanics

Credit System at VNIT :

Education at the Institute is organized around the semester-based credit system of study. The prominent features of the credit system are a process of continuous evaluation of a student's performance / progress and flexibility to allow a student to progress at an optimum pace suited to his/her ability or convenience, subject to fulfilling minimum requirements for continuation. A student's performance/progress is measured by the number of credits he/she has earned, i.e. completed satisfactorily. Based on the course credits and grades obtained by the student, grade point average is calculated. A minimum number of credits and a minimum grade point average must be acquired by a student in order to qualify for the degree.

Course credits assignment

Each course, except a few special courses, has certain number of credits assigned to it depending on lecture, tutorial and laboratory contact hours in a week.
For Lectures and Tutorials: One lecture hour per week per semester is assigned one credit and
For Practical/ Laboratory/ Studio: One hour per week per semester is assigned half credit.
Example: Course XXXXXX with (3-0-2) as (L-T-P) structure, i.e. 3 hr Lectures + 0 hr Tutorial + 2 hr Practical per week, will have (3x1 + 0x1 + 2x0.5 =) 4 credits.

Grading System

The grading reflects a student's own proficiency in the course. While relative standing of the student is clearly indicated by his/her grades, the process of awarding grades is based on fitting performance of the class to some statistical distribution. The course coordinator and associated faculty members for a course formulate appropriate procedure to award grades. These grades are reflective of the student's performance vis-à-vis instructor's expectation. If a student is declared pass in a subject, then he/she gets the credits associated with that subject.

Depending on marks scored in a subject, a student is given a Grade. Each grade has got certain grade points as follows:

Grade	Grade points	Description
AA	10	Outstanding
AB	9	Excellent
BB	8	Very good
BC	7	Good
CC	6	Average
CD	5	Below average
DD	4	Marginal (Pass Grade)
FF	0	Poor (Fail) /Unsatisfactory / Absence from end-sem exam
NP	-	Audit pass
NF	-	Audit fail
SS	-	Satisfactory performance in zero credit core course
ZZ	-	Unsatisfactory performance in zero credit core course
W	-	Insufficient attendance

Performance Evaluation

The performance of a student is evaluated in terms of two indices, viz, the Semester Grade Point Average (SGPA) which is the Grade Point Average for a semester and Cumulative Grade Point Average (CGPA) which is the Grade Point Average for all the completed semesters at any point in time. CGPA is rounded up to second decimal.

The Earned Credits (ECR) are defined as the sum of course credits for courses in which students have been awarded grades between AA to DD. Grades obtained in the audit courses are not counted for computation of grade point average.

Earned Grade Points in a semester (EGP) = **Σ** (Course credits x Grade point) for courses in which AA- DD grade has been obtained

SGPA = EGP / Σ (Course credits) for courses registered in a semester in which AA- FF grades are awarded

CGPA= EGP / Σ(Course credits) for courses passed in all completed semesters in which AA- DD grades are awarded

Overall Credits Requirement for Award of Degree

SN	Category of Course	Symbol	Credit Requirement			
			B. Tech. (4-Year)	B. Arch. (5 Year)	M. Tech. (2 Year)	M. Sc. (2 Year)
	Program Core					
1	Basic Sciences (BS)	BS	18	04	-	-
2	Engineering Arts & Sciences (ES)	ES	20	18	-	-
3	Humanities	HU/ HM*	05	06	-	-
4	Departmental core	DC	79-82	168	33-39	54-57
	Program Elective					
3	Departmental Elective	DE	33-48	17-23	13-19	06-09
4	Humanities & Management	HM	0-6	0-3	-	-
5	Open Course	OC	0-6	0-3	-	-
Total requirement :BS + ES + DC+ DE + HM + OC =			**170**	**219**	**52**	**63**
Minimum Cumulative Grade Point Average required for the award of degree			**4.00**	**4.00**	**6.00**	**4.00**

Attendance Rules

1. All students must attend every class and 100% attendance is expected from the students. However, in consideration of the constraints/ unavoidable circumstances, the attendance can be relaxed by course coordinator only to the extent of not more than 25%. Every student must attend minimum of 75% of the classes actually held for that course.
2. A student with less than 75% attendance in a course during the semester, will be awarded W grade. Such a student will not be eligible to appear for the end semester and re-examination of that course. Even if such a student happens to appear for these examinations, then, answer books of such students will not be evaluated.
3. A student with W grade is not eligible to appear for end semester examination, reexamination & summer term.

<u>Any other relevant information department wishes to add.</u>

Curriculum of the courses of study
First Year (Semester I & II)

Courses to Register in First Year B.Tech.
(*Sections R, S, T, U, L*)

I Semester				
Code	**Course**	**Type**	**L-T-P**	**Credits**
AML151	Engineering Mechanics	ES	3-1-0	4
AMP151	Engineering Mechanics Laboratory	ES	0-0-2	1
HUL101	Communication Skills	HM	2-0-2	3
MAL101	**Mathematics – I**	**BS**	**3-1-0**	**4**
MEL101	Engineering Drawing	ES	3-0-0	3
MEP101	Engineering Drawing Practical	ES	0-0-2	1
PHL101	Physics	BS	3-1-0	4
PHP101	Physics Laboratory	BS	0-0-2	1
SAP101	Health Information and Sports –Part I	AU	0-0-2	0
			Total Credits	21
II Semester				
Code	**Course**	**Type**	**L-T-P**	**Credits**
CHL101	Chemistry	BS	3-1-0	4
CHP101	Chemistry Laboratory	BS	0-0-2	1
CSL101	Computer Programming	ES	3-0-2	4
EEL101	Electrical Engineering	ES	3-1-0	4
EEP101	Electrical Engineering Laboratory	ES	0-0-2	1
HUL102	Social Science	HM	2-0-0	2
MAL102	**Mathematics – II**	**BS**	**3-1-0**	**4**
MEP102	Workshop	ES	0-0-4	2
SAP102	Health Information and Sports –Part II	AU	0-0-2	0
			Total Credits	22

L-T-P = 3-1-0 Means, Three Theory Hrs + One Tutorial hrs + Zero Labs or Practical Hrs per Week. L-T-P = 0-0-2 Means, Two Hrs of Lab or Practical per Week

Courses to Register in First Year B.Tech.

(*Sections W, X, Y, Z, N*)

I Semester				
Code	**Course**	**Type**	**L-T-P**	**Credits**
CHL101	Chemistry	BS	3-1-0	4
CHP101	Chemistry Laboratory	BS	0-0-2	1
CSL101	Computer Programming	ES	3-0-2	4
EEL101	Electrical Engineering	ES	3-1-0	4
EEP101	Electrical Engineering Laboratory	ES	0-0-2	1
HUL102	Social Science	HM	2-0-0	2
MAL101	**Mathematics – I**	**BS**	**3-1-0**	**4**
MEP102	Workshop	ES	0-0-4	2
SAP102	Health Information and Sports –Part I	AU	0-0-2	0
			Total Credits	22
II Semester				
Code	**Course**	**Type**	**L-T-P**	**Credits**
AML151	Engineering Mechanics	ES	3-1-0	4
AMP151	Engineering Mechanics Laboratory	ES	0-0-2	1
HUL101	Communication Skills	HM	2-0-2	3
MAL102	**Mathematics – II**	**BS**	**3-1-0**	**4**
MEL101	Engineering Drawing	ES	3-0-0	3
MEP101	Engineering Drawing Practical	ES	0-0-2	1
PHL101	Physics	BS	3-1-0	4
PHP101	Physics Laboratory	BS	0-0-2	1
SAP101	Health Information and Sports –Part II	AU	0-0-2	0
			Total Credits	21

L-T-P = 3-1-0 Means, Three Theory Hrs + One Tutorial hrs + Zero Labs or Practical Hrs per Week.

L-T-P = 0-0-2 Means, Two Hrs of Lab or Practical per Week

Scheme of Instruction for B.Tech /B.Arch.

Semester – I

Sr. No.	Course Code	Course Name	Type	Structure L-T-P	Credits
1	MAL 101	Mathematics – I	DC	3-1-0	4
2	MAL 103	Mathematics (for B. Arch)	DC	3-1-0	4
	Elective Credits = 0				
	DC = 08_ Credits				

Semester - II

Sr. No.	Course Code	Course Name	Type	Structure L-T-P	Credits
1.	MAL 102	Mathematics – II	DC	3-1-0	4
	Elective Credits = 0				
	DC = 04_ Credits				

Semester - III

Sr. No.	Course Code	Course Name	Type	Structure L-T-P	Credits
1	MAL 201	Integral Transforms and Partial Differential Equations	DC	3-1-0	4
2	MAL 202	Complex variables and Partial Differential equations	DC	3-1-0	4
3	MAL 203	Numerical Methods and Computation	DC	3-1-0	4
4	MAL 206	Linear Algebra and Applications	DC	3-1-0	4
5	MAL 208	Probability Theory and Statistical Methods	DC	3-1-0	4
6.	MAL 211	Complex Variables, Integral Transforms and Partial Differential Equations	DC	3-1-0	4

Semester – IV

Sr. No.	Course Code	Course Name	Type	Structure L-T-P	Credits
1	MAL 205	Numerical Methods and Probability Theory	DC	3-1-0	4
2	MAL 206	Linear Algebra and Applications	DC	3-1-0	4
3	MAL 208	Probability Theory and Statistical Methods	DC	3-1-0	4
4	MAL 209	Discrete Mathematics and Graph Theory	DC	3-1-0	4
5.	MAL 210	Linear Algebra and Partial differential equations	DC	3-1-0	4

Semester – V /VII

Sr. No.	Course Code	Course Name	Type	Structure L-T-P	Credits
1.	MAL 301	Introduction to Operations Research	OC	3-0-0	4
2.	MAL 302	Fractional Calculus	OC	3-0-0	4
3.	MAL 303	Calculus of variations and Integral equations	OC	3-0-0	4
4.	MAL304	Financial Mathematics	OC	3-0-0	4
5.	MAL 305	Wavelet Analysis	OC	3-0-0	4
6.	MAL 401	Finite Difference methods for Differential Equations	OC	3-0-0	4
7.	MAL 403	Numerical Linear Algebra	OC	3-0-0	4
8.	MAL 406	Perturbation Methods	OC	3-0-0	4
9.	MAL 407	Statistics & Optimization Techniques	OC	3-0-0	4
10.	MAL 408	Statistical Analysis and Queuing Theory	OC	3-0-0	4
11.	MAL 410	Introduction to Finite Element Method	OC	3-0-0	4

Semester – VI /VIII

Sr. No.	Course Code	Course Name	Type	Structure L-T-P	Credits
1.	MAL 301	Introduction to Operations Research	OC	3-0-0	4
2.	MAL 302	Fractional Calculus	OC	3-0-0	4
3.	MAL 303	Calculus of variations and Integral equations	OC	3-0-0	4
4.	MAL304	Financial Mathematics	OC	3-0-0	4
5.	MAL 305	Wavelet Analysis	OC	3-0-0	4
6.	MAL 401	Finite Difference methods for Differential Equations	OC	3-0-0	4
7.	MAL 403	Numerical Linear Algebra	OC	3-0-0	4
8.	MAL 406	Perturbation Methods	OC	3-0-0	4
9.	MAL 407	Statistics & Optimization Techniques	OC	3-0-0	4
10.	MAL 408	Statistical Analysis and Queuing Theory	OC	3-0-0	4
11.	MAL 410	Introduction to Finite Element Method	OC	3-0-0	4

Course content description :

MAL101 - MATHEMATICS-I
[(3-1-0); Credit: 4]

Objective: The objective of this subject is to expose student to understand the basic importance of Differential calculus, Integral calculus, Infinite series and Matrix theory in science and engineering.

Course Outcomes (COs)

After completing this course students will be able to

(1) test the convergence of sequence and series.
(2) deal with differential calculus of functions of single variable and its applications.
(3) understand concepts of integration of function of single variable and its applications.
(4) understand basic concepts of matrix theory and can apply it to solve problems of Engineering.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1									2
CO2	3	2	1									2
CO3	3	2	1									2
CO4	3	2	1									2

Content (CO wise):

Sequences and Series:

Sequences of real and complex numbers, Monotonic sequence, Bounded Sequences, Convergence of Sequence.

Infinite series, tests of convergence (Comparison test, Ratio test, Root test, Raabe's test, Logarithm test and Integral test statements only), absolute and conditional convergence, power series, radius of convergence.

Differential Calculus of function of single variable:

Review of limit, continuity, and differentiability. Mean value theorems: Rolle's theorem, Lagrange's theorem, Cauchy's theorem, Taylor's theorem with Lagrange's form of remainder, curve tracing.

Integral Calculus:

Fundamental theorem of Integral calculus, mean value theorems, evaluation of definite integrals.

Differentiation under integral sign including variables limits-Leibnitz rule (without proof).

Applications in area, length, volumes, and surface of solids of revolutions.

Improper integrals and tests for convergence, Beta and Gamma functions,

Matrices:

Gauss-Elimination and Gauss-Jordan Elimination methods for solving system of linear equations, Rank of matrix, consistency of a system of equations,linear dependence and independence, linear and orthogonal transformations, Eigenvalues and eigenvectors, Cayley-Hamilton theorem, reduction to diagonal form, Hermitian and skew Hermitian matrices, Quadratic forms.

Text Books/ Reference Books:

1) James Stewart, Calculus-Early transcendentals 5e, Thomson™ Brooks/Cole -Indian Edition, 2007

2) Thomas, G.B. and Finney, R.L., Calculus and Analytic Geometry (Ninth Edition); Addison

Wesley Longman, Inc.
3) Kreyszig, E, Advanced Engineering Mathematics (Eighth Edition); John Wiley & Sons.
4) Jain, R.K. and Iyengar, S.R.K., Advanced Engineering Mathematics; Narosa Publishers.
5) Piskunov, N., Differential and Integral calculus, Vol.1, Vol.2 MIR Publishers, Moscow – CBS Publishers and Distributors (India).
6) Sudhir R. Ghorpade, Balmohan V. Limaye, A Course in Calculus and Real Analysis, 2nd Edition, Springer, New York, NY. 2018.

MAL102 - MATHEMATICS-II

[(3-1-0); Credit: 4]

Objective: The objective of this subject is to expose student to understand the basic importance of multi variable calculus (Differential calculus & Integral calculus), Vector calculus and ordinary differential equations in engineering.

Course Outcomes (COs)

After completing this course students will be able to

(1) deal with differential calculus of functions of several variables and their applications.
(2) understand concepts of multipleintegrals and their applications in Engineering problems.
(3) understand the concepts of vector calculus and its applications in Engineering and Science.
(4) solve certain class of ordinary differential equations related to Science and Engineering.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1									2
CO2	3	2	1									2
CO3	3	2	1									2
CO4	3	2	1									2

Content (CO wise):

Calculus of function of Several Variables:

Limit, continuity, and differentiability of functions of several variables, partial derivatives and their geometrical interpretation, Tangent plane, and normal line. Euler's theorem on homogeneous functions, Total differentiation, chain rules, Jacobian, Taylor's formula, maxima and minima, saddle points, Lagrange's method of undetermined multipliers.

Multiple Integrals:

Double integrals, change of order of integration, change of variables, application to area, volumes, Mass, Centre of gravity.

Triple integrals, change of variables in triple integrals. Application of triple integral to find volume, mass, centre of mass and moments of inertia about the axes of a solid.

Vector Calculus:

Scalar and vector fields, gradient of scalar point function, directional derivatives, divergence, and curl of vector point function, solenoidal and irrotational motion.

Vector integration: line, surface and volume integrals, Green's theorem, Stoke's theorem and Gauss divergence theorem (without proof).

Ordinary Differential Equations:

First order differential equations: Exact equation, Integrating factors, Reducible to exact differential equations, Linear and Bernoulli's form, orthogonal trajectories, Existence and Uniqueness of solutions. Picard's theorem, Picard's iteration method of solution (Statements only). Solutions of second and higher order linear equations with constant coefficients, Linear independence and dependence, Method of variation of parameters, Solution of Cauchy's equation, simultaneous linear equations.

Text Books/ Reference Books:

. Kreyszig, E. ; Advanced Engineering Mathematics (Eighth Edition); John Wiley & Sons.

2. Jain, R.K. and Iyengar, S.R.K.; Advanced Engineering Mathematics; Narosa Publishers.

3. Thomas, G.B. and Finney, R.L.; Calculus and Analytic Geometry (Ninth Edition); Addison Wesley Longman, Inc.

4. Michael D. Greenberg: Advanced Engineering Mathematics, Pearson Education Pvt. Ltd.

5. Piskunov, N. : Differential and Integral calculus, Vol. 1, Vol. 2, MIR Publishers, Moscow - CBS Publishers and Distributors (India).

6. Sudhir R. Ghorpade, Balmohan V. Limaye, A Course in Multivariable Calculus and Analysis, Springer, New York, NY, 2010.

MAL 103 – Mathematics (for B. Arch)
[3-1-0; Credits 4]

Objective: The objective of this subject is to expose student to understand the basic concepts of differential and integral calculus, ordinary differential equations, matrix theory, three dimensional geometry and basic statistics.

Course Outcomes (COs)

After completing this course students will be able to

(1) get the exposure to understand the concepts of calculus and its applications.
(2) solve certain class of ordinary differential equations related to Engineering.
(3) understand basic concepts of matrix theory and can apply it to solve problems of Engineering.
(4) know the basic concepts of three-dimensional geometry.
(5) deal with problems related to central tendencies, dispersion and curve fitting.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1									2
CO2	3	2	1									2
CO3	3	2	1									2
CO4	3	2	1									2
CO5	3	2	1									2

Content (CO wise):

Calculus:

Tangent and Normal, Maxima and minima of functions of one variable, Curvature (Cartesian and Parametric form), Curve tracing, Taylor's and Maclaurin's expansion for one variable, Indeterminate forms, partial differentiation, Maxima and minima of functions of two variables.

Double integrals, Calculation of areas using double integrals (Cartesian and Polar), Applications of double integrals for Centre of gravity and Moment of inertia.

Ordinary Differential Equations:

First order ODEs: Method of solution, orthogonal trajectories, Newton's law of cooling.
Second and higher order linear ODEs: Solution of homogeneous and non-homogeneous linear equations with constant coefficients, Applications

Matrices:

Review of inverse of a square matrix using Adjoint matrix. Rank of a matrix, consistency and inconsistency of system of linear equations, solution of LPP using graphical method.

Three Dimensional Geometry:

Directional Cosines and ratio's, angle between two lines, equations of straight line, coplanar lines, equation of plane, shortest distance between lines and planes, tangent plane and normal line,sphere.

Statistics:

Arithmetic mean, median, mode, standard deviation and variance, regression and correlation;
Curve fitting, method of least squares (Straight line and parabola).

Reference Books:

1. Kreyszig, E., Advanced Engineering Mathematics, 8th Edition, John Wiley & Sons, New York 2008.
2. Thomas G.B., Calculus and Analytical Geometry, Addison Wesley, London, 1998.
3. Grewal B.S., Higher Engineering Mathematics, Khanna Publishers, New Delhi, 2011.
4. Jain, R.K. and Iyengar, S.R.K.; Advanced Engineering Mathematics; Narosa Publishers 2005.
5. Piskunov, N. : Differential and Integral calculus, Vol. 1, Vol. 2, MIR Publishers, Moscow - CBS Publishers and Distributors (India),1996.
6. James Stewart, Calculus -Early Transcendental, Thomson Brooks/Cole, 2008.

MAL 201: Integral Transforms and Partial Differential Equations
[(3-1-0); Credit: 4]

Objective: The objective of this subject is to expose student to understand the importance of transform techniques to solve real world problems. It also focuses the partial differential equations and its applications in science and engineering.

Course Outcomes (COs)

After completing this course students will be able to

(1) know the fundamentals of Laplace transform, inverse Laplace transform and its properties. Apply the Laplace transform techniques to solve ordinary differential equations.
(2) understand the fundamentals of Fourier series expansion and Fourier transform. Explore the properties of Fourier series & Fourier transform and its applications in Science and Engineering.
(3) expose the concepts of the solutions to the PDE over the bounded domain.
(4) understand the fundamentals and applications of Z-transform.

Laplace Transforms: Definition of Laplace Transforms, Linearity property, condition for existence of Laplace Transform, first and second shifting properties, transforms of derivatives and integrals, evaluation of integrals by Laplace Transform. Inverse Laplace Transform, convolution theorem, Laplace Transform of periodic functions, unit step function and Dirac delta function. Applications of Laplace Transform to solve ordinary differential equations.

Fourier Series and Fourier Transforms: Fourier series, half range sine and cosine series expansions, exponential form of Fourier series. Fourier integral theorem, Fourier transform, Fourier Sine and cosine Transforms, Linearity, scaling, frequency shifting and time shifting properties, convolution theorem.

Partial differential equations: Classification of linear second order PDEs, method of separation of variables, Solution of One dimensional wave equation, heat equation, Laplace equation (Cartesian and polar forms), D'Alembert solution of wave equation.

Z-transform: Z - transform, Properties of Z-transforms, Convolution of two sequences, inverse Z-transform, Solution of Difference equations.

Text Books / Reference Books:

1. Kreyszig, E. ; Advanced Engineering Mathematics (Eighth Edition); John Wiley & Sons.
2. Jain, R.K. and Iyengar, S.R.K.; Advanced Engineering Mathematics; Narosa Publishers.
3. Thomas, G.B. and Finney, R.L.; Calculus and Analytic Geometry (Ninth Edition); Addison Wesley Longman, Inc.

MAL 202 - Complex Variables and Partial Differential Equations
[(3-1-0); Credit: 4]

Objective: The objective of this subject is to expose student to understand the importance of complex variables. It also focuses the partial differential equations and its applications in science and engineering.
Course Outcomes (COs)

Content (CO wise):
Laplace Transforms: Definition of Laplace Transforms, Linearity property, condition for existence of Laplace Transform, first and second shifting properties, transforms of derivatives and integrals, evaluation of integrals by Laplace Transform. Inverse Laplace Transform, convolution theorem, Laplace Transform of periodic functions, unit step function and Dirac delta function. Applications of Laplace Transform to solve ordinary differential equations.

Complex variable: Functions of a complex variable - continuity - differentiability - analytic functions - complex integration - Cauchy's integral theorem. Cauchy's integral formula, Taylor's theorem - Laurent's theorem , zeros of an analytic function – singularities, Residue - Cauchy's residue theorem - contour integration.

Fourier Series and Fourier Transforms: Fourier series, half range sine and cosine series expansions, exponential form of Fourier series. Fourier integral theorem, Fourier transform, Fourier Sine and cosine Transforms, Linearity, scaling, frequency shifting and time shifting properties, convolution theorem.

Partial differential equations: Classification of linear second order PDEs, method of separation of variables, Solution of One dimensional wave equation, heat equation, Laplace equation (Cartesian and polar forms), D'Alembert solution of wave equation.

Text Books/ Reference Books:

1. Kreyszig, E. ; Advanced Engineering Mathematics (Eighth Edition); John Wiley & Sons, 1998
2. R.V. Churchill and Brown : Complex variables and applications, McGraw Hill, 2001.
3. Jain, R.K. and Iyengar, S.R.K.; Advanced Engineering Mathematics; Narosa Publishers, 2005.
4. Copson, E.T. : Theory of complex variables, Oxford University Press, 1988.

MAL203 - Numerical Methods and Computation
[(3-0-1); Credit: 4]

Objective: The objective of this subject is to make the students aware of the numerical methods for the solution of scientific problems which cannot be solved analytically.

Course Outcomes (COs)

Upon completion of the course, students would be able to:

(1) Apply different interpolation techniques in the engineering problems.
(2) Exploit numerical integration techniques for approximating the integrals.
(3) Apply various numerical techniques to solve transcendental and algebraic equations.
(4) Solve system of linear algebraic equations, nonlinear system of equations and eigenvalue problems.
(5) Design and implement numerical methods to approximate the solutions of initial value problems and boundary value problems arising in engineering

Content (CO wise):

Interpolation: Existence, Uniqueness of interpolating polynomial, error of interpolation - unequally spaced data; Lagrange's_formula, Newton's divided difference formula. Equally spaced data : finite difference operators and their properties, Gauss's forward and backward, Sterling's formulae - Inverse interpolation - Hermite interpolation.

Differentiation: Finite difference approximations for first and second order derivatives.

Integration: Newton-cotes closed type methods; particular cases, error terms - Newton cotes open type methods - Romberg integration Gaussian quadrature; Legendre formulae.

Solution of nonlinear and transcendental equations: Regula Falsi method, Newton-Raphson method, Newton Raphson method for system of nonlinear equations.

Solution of linear algebraic system of equations: LU Decomposition, Gauss-Seidal methods; solution of tridiagonal system. Ill conditioned equations. Eigen values and eigen vectors : Power and Jacobi methods.

Solution of Ordinary differential equations:
Initial value problems: Single step methods; Taylor's, Euler's, Runge-Kutta methods, Implicit Runge Kutta methods Boundary value problems: Finite difference methods, Shooting method.

Text Books/ Reference Books:

1. Jain, Iyengar and Jain : Numerical Methods for Engineers and Scientists, Wiley Eastern.
2. S. D. Cante and C**.** de Boor, Elementary Numerical Analysis, an algorithmic approach, McGraw-Hill.
3. Gerald and Wheatley : Applied Numerical Analysis, Addison-Wesley.
4. Aitkinson : Numerical Analysis, John Wiley and Sons.

MAL 205- Numerical Methods and Probability Theory
[(3-1-0); Credits: 4]

Objective: The broad objective of the course is to teach basic concepts of the numerical methods, their rate of convergence and applications to physical problems.

Course Outcomes (COs):

Upon completion of this course, the students will be able to:

(1) Employ a number of techniques to solve transcendental and algebraic equations. Know how to solve a system of nonlinear equations by Newton-Raphson method.

(2) Efficiently solve a system of linear equations and find their eigenvalues and eigenvectors. Design and implement numerical methods for numerical approximation of initial value problems as well as two-point boundary value problems.

(3) Apply the concepts such as random variables, probability density function, cumulative distribution function, and joint probability density function in the engineering and science problems.

(**4**) Analyze and apply the concepts such as mathematical expectation, functions of random variables, variance, standard deviations, moment generating function, Skewness and Kurtosis. Exploit different probability distributions such as Binomial, Geometric distribution, Poisson distribution, and normal distribution in the engineering and science problems.

Content (CO wise):

Numerical Analysis: Solutions of algebraic and transcendental equations by Iteration method, method of false position, Newton-Raphson method and their convergence.
Solutions of system of linear equations by Gauss elimination method, Gauss Seidal method, LU decomposition method. Newton-Raphson method for system of nonlinear equations.
Eigen values and eigen vectors: Power and Jacobi methods.
Numerical solution of ordinary differential equations: Taylor's series method, Euler's modified method, Runge-Kutta method, Adam's Bashforth and Adam's Moulton, Milne's predictor corrector method. Boundary value problems: Shooting method, finite difference methods.

Probability theory:
Random variables, discrete and continuous random variable, probability density function; probability distribution function for discrete and continuous random variable joint distributions.

Definition of mathematical expectation, functions of random variables, The variance and standard deviations, moment generating function other measures of central tendency and dispersion, Skewness and Kurtosis. Binomial, Geometric distribution, Poisson distribution, Relation between Binomial and Poisson's distribution, Normal distribution, Relation between Binomial and Normal distribution. Introduction to Stochastic Processes.

Textbooks / **Reference Books** :

1. Jain, Iyengar and Jain : Numerical Methods for Engineers and Scientists, WileyEastern
2. V.K. Rohatgi and A.K.M. Ehsane: An Introduction to Probabability and Statistics, John Wiley & Sons
3. S. D. Cante and C. de Boor, "Elementary Numerical Analysis, an algorithmic approach", McGraw-Hill.
4. Gerald and Wheatley: "Applied Numerical Analysis", Addison-Wesley.
5. Spiegel, M.R.; "Theory and problems of Probability and statistics"; McGraw-HillBookCompany; 1980.
6. K.S. Trivedi: "Probability Statistics with Reliability, Queuing and Computer Science applications", Prentice Hall ofIndia Pvt. Ltd.

MAL206 - Linear Algebra and Applications
[(3-1-0); Credit: 4]

Objective: The objective of this subject is to expose student to understand the basic importance of Linear Algebra and its applications its applications to science and engineering.

Course Outcomes (COs):

After completing this course students will be able to

1. Apply the matrix calculus in solving a system of linear algebraic equations
2. Understand the basic concepts of linear algebra such as vector space, basic vector operations, basis, dimension and Linear transformations etc
3. Relate matrices and linear transformations, compute Eigen values and Eigen vectors of linear transformations and obtain various variants of diagonalisation of linear transformations.
4. Learn properties of inner product spaces and determine orthogonality in inner product spaces.
5. Understand the importance of linear algebra and its applications to science and engineering

Matrices: Review of Matrix Algebra; Rank of matrix; Row reduced Echelon form; Determinants and their properties; Solution of the matrix Equation Ax = b; Gauss elimination method.

Vector space, subspaces, linear dependence/independence, basis, dimension, linear transformation, range space and rank, null space and nullity, rank nullity theorem. matrix representation of a linear transformation, linear operators on R^n and their representation as square matrices, invertible linear operators, inverse of a non-singular matrix.

Eigen values and eigenvectors of a linear operator, properties of eigen values and eigenvectors of Hermitian, skew-Hermitian, unitary, and normal matrices (symmetric, skew-symmetric, and orthogonal matrices), characteristic equation, bounds on eigen values, Cayley-Hamilton theorem, diagonalizability of a linear operator, invariant sub spaces, annihilators, minimal polynomials.

Inner product spaces, norm; ortho normal sets, Gram-Schmidt orthogonalisation process; projections and least squares approximation, Ad-joint operator, normal, unitary and self-adjoint operator. Spectral theorem for normal operator, applications of linear algebra in engineering.

Text books/ References:

1. G. Strang, Linear algebra and its applications , Thomson Publications.
2. E. Kreyszig, Advanced engineering mathematics , John Wiley publications .
3. Hoffman and Kunje, Linear Algebra, Prentice Hall of India.
4. S. Kumaresan, Linear algebra - A Geometric approach, Prentice Hall of India.
5. Nagpaul, First course in Linear Algebra, Wiley Eastern Ltd, New Delhi.

MAL 208 - Probability and Statistics for Engineering
[(3-1-0); Credit: 4]

Objective: The objective of this subject is to expose student to understand the importance of probability theory and statistical analysis in science and engineering.

Course Outcomes (COs):

(1) Understand the significance of probability and statistics in real life, engineering and industrial applications, Also will be able to grab the theoretical foundations of conditional probability, random variables, joint distributions, transformations.
(2) Learn some significant special discrete and continuous distributions.
(3) Be able to use sampling theory, estimation, decision making and regression.
(4) Formulate probabilistic and statistical models of real life/ engineering problems and use them.

Probability

Random Variable & Probability Distributions: Random Variables, Density function, distribution function for continuous and discrete random variables, Joint distributions.

Mathematical Expectation: Mathematical Expectation, The variance and Standard deviation, Moment Generating Function, Characteristic Function.

Special Probability Distributions: Some special probability distributions like Binomial Poisson, Geometric, Normal, Uniform, Exponential Gamma Beta, Chi-Square, Students‘t’, F-distribution and Weibull Distribution.

Statistics

Moments, correlation, covariance and regression.

Sampling Theory: Population Parameter, Sample Statistics, Sampling distributions, Sample mean, Sampling distribution of means, The Sample variance, The sampling distribution of variance.

Estimation Theory: Point estimate and Interval Estimates, Reliability, Confidence interval estimates of population parameters, confidence intervals for means, proportions and variance .

Tests of Hypothesis and Significance: Statistical decisions, Tests of hypothesis and significance. Type I and Type II errors. Level of significance, one tailed and two tailed tests. Tests involving small samples and large samples. Fitting theoretical distributions to sample frequency distribution .The chi-square test for goodness of fit.

Text Books/ Reference Books:

1. Paul L. Meyer, Introductory Probability and Statistical Applications, Addison Wesley.
2. Miller and Freund: Probability and Statistics for Engineers Eastern Economy Edition, PHI.
3. E.Parzen: Modern Probability Theory and Its Applications J. Wiley and Sons Inc., New York.
4. M.R.Speigal: Probability and Statistics, McGraw-Hill, 1995.
5. V.K. Rohatgi and A.K.M. Ehsanes Sateh: An Introduction to Probability and Statistics, John Wiley & Sons.

MAL209 –Discrete Mathematics and Graph Theory
[(3-1-0); Credit: 4]

Objective: The objective of this subject is to make the students aware of sets, relations, functions, Boolean algebra and graph theory and its applications in science and engineering.

Course Outcomes (COs):

Sets and propositions: Combinations of sets, Finite and Infinite sets, uncountable infinite sets, principle of inclusion and exclusion, mathematical induction. Propositions, fundamentals of logic, first order logic, ordered sets.

Permutations, combinations, numeric functions, generating functions.
Recurrence relations and recursive algorithms: recurrence relations, linear recurrence relations with constant coefficients, homogeneous solutions, particular solutions, total solutions, solution by the method of generating functions, sorting algorithm.

Relations and functions : properties of binary relations, equivalence relations and partitions, partial and total ordering relations, Transitive closure and Warshal's algorithm.

Boolean algebra : Chains, Lattices and algebraic systems, principle of duality, basic properties of algebraic systems, distributive and complemented lattices, Boolean lattices and algebras, uniqueness of finite Boolean algebras, Boolean expressions and functions.

Graphs and planar graphs : Basic terminology, multigraphs and weighted graphs, paths and circuits, shortest paths in weighted graphs, Eulerian paths and circuits, Hamiltonian paths and circuits. Colorable graphs, Chromatic numbers, Five color theorem and Four color problem. Trees and cut-sets : trees, rooted trees, path lengths in rooted trees, spanning trees and BFS & DFS algorithms, minimum spanning trees and Prims & Kruskal's algorithms.

Text Books:

1. Mott, Kandel and Baker, Discrete Mathematics for Computer Scientists, PHI.
2. C.L.LIU, Elements of Discrete Mathematics, McGraw Hill.
3. Tremblay and Manohar, Discrete Mathematical Structures with applications to Computer Science, McGraw Hill Book Co.

MAL 210 - Linear Algebra and Partial differential equations
[(3-1-0); Credit: 4]

Course Outcomes (COs)

After completing this course students will be able to

1. Understand the basic concepts of linear algebra such as vector space, basic vector operations, basis, dimension and Linear transformations etc
2. Relate matrices and linear transformations, compute Eigen values and Eigen vectors of linear transformations and obtain various variants of diagonalisation of linear transformations.
3. understand the fundamentals of Fourier series expansion and Fourier transform. Explore the properties of Fourier series & Fourier transform and its applications in Science and Engineering.
4. expose the concepts of the solutions to the PDE over the bounded domain.

Vector space, subspaces, linear dependence/independence, basis, dimension, linear transformation, range space and rank, null space and nullity, rank nullity theorem. matrix representation of a linear transformation, linear operators on R^n and their representation as square matrices, invertible linear operators, inverse of a non-singular transformations.

Eigenvalues and eigenvectors of a linear operator, characteristic equation, bounds on Eigenvalues, diagonalizability of a linear operator, invariant subspaces, annihilators, minimal polynomials. Inner product spaces, vector and matrix norms; orthonormal sets, Gram-Schmidt orthogonalization process; projections and least squares approximation, Adjoint operator, normal, unitary and self-adjoint operator., Spectral theorem for normal operator, Singular Value Decompositions, QR decomposition.

Fourier series, half range sine and cosine series expansions, exponential form of Fourier series.

Classification of linear second order partial differential equations, method of separation of variables, Solution of One-dimensional wave equation, heat equation, Laplace equation (Cartesian and polar forms).

Text books/ References:

1. G. Strang, Linear algebra and its applications (4th Edition), Thomson Publications, 2006.
2. E. Kreyszig, Advanced engineering mathematics, John Wiley publications 10th Edition, 2011.
3. K. M . Hoffman and R. Kunje, Linear Algebra, Prentice Hall of India, Second Edition, 2003.
4. S. Kumaresan, Linear algebra - A Geometric approach, Prentice Hall of India, 2019.
5. Jain, R.K. and Iyengar, S.R.K.; Advanced Engineering Mathematics, Narosa Publishers, 2005.
6. H. Anton, Elementary Linear Algebra, 11th Edition, Wiley, New York, 2019.

MAL 211 - Complex Variables, Integral Transforms and Partial Differential Equations
[(3-1-0); Credit: 4]

Objective: The objective of this subject is to expose student to understand the importance of complex variables. It also focuses the partial differential equations and its applications in science and engineering.

Course Outcomes (COs)
After completing this course students will be able to
(1) Analyze complex variable function's continuity, differentiability, analyticity and can compute complex integrals.
(2) know the fundamentals of Laplace transform, inverse Laplace transform and its properties. Apply the Laplace transform techniques to solve ordinary differential equations.
(3) understand the fundamental of Fourier series expansion and Fourier transform. Explore the properties of Fourier series & Fourier transform and its applications in Science and Engineering.
(4) understand the fundamentals and applications of Z-transform.
(5) expose the concepts of the solutions to the PDE over the bounded and unbounded domain.

Complex variable: Functions of a complex variable - continuity, differentiability, analyticity. Zeros of an analytic function – singularities, Residue, Cauchy's residue theorem, complex integration - Cauchy's integral theorem (statement only), Cauchy's integral formula (statement only), Taylor's theorem - Laurent's theorem (statement only) , contour integration.

Laplace Transforms: Definition of Laplace Transforms, Linearity property, condition for existence of Laplace Transform, first and second shifting properties, transforms of derivatives and integrals, evaluation of integrals by Laplace Transform. Inverse Laplace Transform, convolution theorem, Laplace Transform of periodic functions, unit step function and Dirac delta function. Applications of Laplace Transform to solve ordinary differential equations.

Fourier Series and Fourier Transforms: Fourier series, half range Sine and Cosine series expansions, exponential form of Fourier series. Fourier integral theorem, Fourier transform, Fourier Sine and Cosine Transforms, Linearity, scaling, frequency shifting and time shifting properties, convolution theorem.

Z-transform: Z - transform, Properties of Z-transforms, Convolution of two sequences, inverse Z transform, Solution of Difference equations.

Partial differential equations: Classification of linear second order PDEs, method of separation of variables, Solution of One-dimensional wave equation, heat equation, Laplace equation (Cartesian and polar forms).

Text Books/ Reference Books:

1. E. Kreyszig, Advanced engineering mathematics, John Wiley publications 10th Edition, 2011.
2. J. W Brown and R.V. Churchill: Complex variables and applications, McGraw Hill, 8^{th} edition, 2009.
3. Jain, R.K. and Iyengar, S.R.K., Advanced Engineering Mathematics; Narosa Publishers, 2005.
4. Copson, E.T. : Theory of complex variables, Oxford University Press, 1988.

MAL 301 –Operations Research
[(3-0-0); Credit: 3]

Objective: The objective of this subject is to expose student to understand the optimization technique for solving Linear and Non Linear programming problems.

Course Outcomes (COs):

After completing this course students will be able to

1. Understand various methods for solving Linear Programming Problems.
2. Familiar with algorithms for solving Transportation problems and Assignment problem
3. Will be able to understand the approaches available to solve non-linear problems.
4. Will be exposed to understand the methods which are inherent in software packages for solving Optimization problems.

Content (CO wise):

Linear Programming : Formulation of a Linear Programming Problem - Graphical solution - Simplex method (including Big M method and two phase method) - Dual problem - duality theory - dual simplex method - revised simplex method.

Transportation problem - existence of solution - degeneracy - MODI method.

Assignment problem: travelling salesman problem.

Dynamic programming: Multistage decision process-concept of sub optimization-principle of optimality-computational procedure in dynamic programming -Application to problems involving discrete variables, continuous variables and constraints involving equations and inequalities.

Nonlinear programming problem (NLPP): Constrained NLPP, Lagrange's multipliers method -convex NLPP, Kuhn-Tucker conditions.

Text Books/ Reference Books :

1. J.C. Pant: Introduction to Optimization: Operations Research, Jain Brothers, New Delhi.
2. Kanti Swarup et. al. : Operations Research, Sultan Chand and Co.
3. H.A.Taha: Operations Research, An Introduction, PHI.
4. S.S. Rao: Engineering Optimization: Theory & Practice, New Age International (p) Limited, 1998.
5. H.M.Wagner : Principles of Operations Research, Prentice Hall of India, New Delhi, 1982.
6. Kambo : Mathematical Programming Techniques, East-West Publishers, New Delhi, 2008.

MAL302 –Fractional Calculus
[(3-0-0); Credit: 3]

Objective:
The main objective of this course is to introduce the fractional-order calculus and its applications in science and engineering.
Course Outcomes (COs):

Content (CO wise):
Functions used in Fractional Calculus.
Gamma Function, Beta Function, Mittag-Leffler Function, Wright Function, Hyper geometric Functions.

Fractional Derivatives and Integrals.
Grünwald-Letnikov Fractional Derivatives, Riemann- Liouville Fractional Derivative, Riemann- Liouville Fractional Integral, Caputo's Fractional Derivative, Fractional Integral Equations (First and Second kind), Geometric and Physical Interpretation of Fractional Integration and Fractional Differentiation. Left and Right Fractional Derivatives. Properties of Fractional Derivatives. Laplace Transforms of Fractional Derivatives and Fractional Integrals. Fourier Transforms of Fractional Derivatives and Fractional Integrals.

Linear Fractional Differential Equations.
Fractional Differential Equation of a General Form, Existence and Uniqueness Theorem as a Method of Solution, Dependence of a Solution on Initial Conditions.

Methods for the Solution of Fractional-order Equations.
The Laplace Transform Method, The Mellin Transform Method, Power Series Method. Babenko's Symbolic Calculus Method, Fractional Green's function.

Text Books/ Reference Books:

1. I. Podlubny, Fractional Differential Equations, Academic Press, San Diego, 1999.
2. S. Das, Functional Fractional Calculus, Springer Berlin, 2011.
3. Miller KS & Ross B. An introduction to the fractional calculus. New York: John Wiley.
4. Oldham KB & Spanier J. The fractional calculus. New York: Academic Press.
5. A.A Kilbas, H.M. Srivastava, and J.J. Trujillo, J.J. Theory and Applications of Fractional Differential Equations, Elsevier, Amsterdam.

MAL303- Calculus of Variations and Integral equations
[(3-0-0); Credit: 3]

Objective: The objective of this subject is to expose student to understand the basic importance of special functions, calculus of variations and integral equations.
Course Outcomes (COs):

Content (CO wise):

Special Functions: Series solutions, Frobenius method, Legendre equation, Bessel equation, Legendre Polynomials, Bessel function of first kind, Sturm – Liouville Problems.

Calculus of Variations: Variation and its properties, Euler's equation, Functional dependent on higher order derivatives, functional dependent of the functions of several independent variables, variational problems in parametric form, applications, variational problems with moving boundaries, variational problems involving a conditional extremum, Direct methods – Ritz method, Kantorovich's method.

Integral Equations: Volterra Integral Equations: Basic concepts, Relationship between linear differential equations and Volterra integral equations, Resolvent Kernel of Volterra Integral equation, Solution of integral equations by Resolvent Kernel, Method of successive approximations, Convolution type equations, Solution of integral differential equations with the aid of Laplace transformation.

Fredholm Integral equations: Fredholm equations of the second kind, Fundamentals - Iterated Kernels, Constructing the resolvent Kernel with the aid of iterated Kernels, Integral equations with degenerate kernels, Characteristic numbers and eigen functions, Solution of homogeneous integral equations with degenerate kernel, Non-homogeneous symmetric equations, Fredholm alternative.

Text Books:

1. I.Sneddon, The Use of Integral Transforms (Tata McGraw Hill), 1974.
2. Hildebrand, Methods of Applied Mathematics, Dover Publications; 2nd edition, 1992.
3. L. Elsgolts, Differential equations and calculus of variations, MIR publisher, Moscow.

Reference Books:

1. Krasnov, Problems and Exercises in Integral Equations (Mir Publ.), 1971.
2. Ram P Kanwal, Linear Integral Equations (Academic Press), 1971.
3. F.G.Tricomi, Integral Equations, Dover Publications, (1985).
4. R. V. Churchill and J. W. Brown, Fourier series and boundary value problems (7th Edition), McGraw-Hill (2006).
5. Jain, R.K. and Iyengar, S.R.K.; Advanced Engineering Mathematics; Narosa Publishers, 2005.
6. E. Kreyszig, Advanced engineering mathematics (8th Edition), John Wiley (1999).

MAL304 –Financial Mathematics
[(3-0-0); Credit: 3]

Prerequisite: Probability and Statistics for Engineering (MAL 205) and Operations Research (MAL 301).

Objective:
The main objective of this course is to introduce the financial mathematics and is applications to marketing.

Course Outcomes(COs)
After completing this course, students will be able to

1. Grasp basic terminologies of financial mathematics like, Financial assets, securities, bonds, risk Stocks, Short selling, Portfolio, Options, Forward, Put and Call etc. and its use in Finance.
2. Understand the Mathematics of basic theory of option Pricing, Single and Multi-period binomial pricing model, Binomial Lattice model, Black-Scholes formula and its application in predicting the price of the European and American call and put option.
3. Know about risk and return of an asset, Capital asset pricing model, Theoretical and computational Issues of Markowitz model of portfolio Optimization.
4. Understand the concept of Stochastic Processes, Stochastic Calculus, Filtration and Martingales and its application in predicting the price of the European and American call and put option.

Content (CO wise):

Some Basic definitions and terminology.

Basic Theory of Option Pricing: Single and Multi-Period Binomial Pricing Models, Cox-Ross-Rubinstein (CRR) Model, Black-Scholes Formula for Option Pricing as a Limit of CRR Model.

Brownian and Geometric Brownian Motion, Theory of Martingales. Stochastic Calculus, Stochastic Differential Equations, Ito's Formula to Solve SDE's. Applications of Stochastic Calculus in Option Pricing.

Mean-Variance Portfolio Theory: Markowitz Model of Portfolio Optimization and Capital Asset Pricing Model (CAPM). Limitations of Markowitz Model and New Measures of Risk.

Interest Rates and Interest Rate Derivatives: Binomial Lattice Model, Vasicek, Hull and White Models for Bond Pricing.

Text books/ Reference Books:

1. D. G. Luenberger: Investment Science, Oxford University Press.
2. M. Capińsky and T. Zastawniak: Mathematics for Finance: An Introduction to Financial Engineering, Springer.
3. Thomas Mikosch: Elementary Stochastic Calculus with Finance in view, World Scientific.
4. Suresh Chandra, S. Dharmaraja, Aparna Mehra, R. Khemchandani: Financial Mathematics: An Introduction, Narosa Publishing House.
5. S. E. Shreve: Stochastic Calculus for Finance, Vol. I & Vol. II, Springer.
6. Sean Dineen: Probability Theory in Finance: A Mathematical Guide to the Black-Scholes Formula American Mathematical Society, Indian edition.

MAL305 –Wavelet Analysis
[(3-0-0); Credit: 3]

Objective: The main objective of this course is to introduce the wavelet Analysis.
Course Outcomes (COs):

Content (CO wise):

Heuristic treatment of the wavelet transform – wavelet transform – Haar wavelet expansion : Haar functions and Haar series, Haar sums and Dyadic projections, completeness of the Haar functions, Haar series in C_0 and L_p spaces, pointwise convergence of Haar series, construction of standard Brownian motion,

Haar function representation of Brownian motion – Multiresolution analysis : Orthogonal systems, scaling functuions, from scaling function to MRA, Meyer wavelets, from scaling function to orthonormal wavelet – Wavelets with compact support : from scaling filter to scaling function, explicit representation of compact wavelets, Daubechies recipe, Hernandez-Weiss recipe,

Smoothness of wavelets - convergence properties of wavelet expansions: wavelet series in L^p spaces, large scale analysis, almost everywhere convergence, convergence at a preassigned point – Wavelets in several variables: tensor product of wavelets, general formulation of MRA and wavelets in R^d, Examples of wavelets in R^d.

Text Books:

1. Mark A. Pinsky : Introduction to fourier analysis and wavelets, Cenage Learning India Pvt. Ltd, 2002.

2. M.V.Altaisky : Wavewlets Theory, Applications Implementation, University Press, 2009

MAL401 – Finite Difference methods for Differential equations
[(3-0-0); Credit: 3]

Objective: The objective of this subject is to expose student to understand the importance of finite difference methods for solving ordinary and partial differential equations.

Course Outcomes (COs):

After completing this course students will be able to

1. Solve the boundary value problems in ordinary differential equations using finite difference methods
2. Understand different types of methods for solving Parabolic, Hyperbolic and Elliptic Partial differential equations.
3. Will be exposed to understand the methods which are inherent in software packages for solving various engineering problems.
4. Will be exposed to apply these finite difference methods for solving various problems in science and engineering.

Content (CO wise):

Finite difference methods: finite difference approximations for derivatives, boundary value problems with explicit boundary conditions, implicit boundary conditions, Quasilinearization, Cubic splines and their application for solving two point boundary value problems.

Solution of Partial Differential Equations: Classification of partial differential equations, finite difference approximations for partial derivatives and finite difference schemes for:

Parabolic equations: Schmidt's two level, multilevel explicit methods, Crank-Nicolson's method.

Hyperbolic Equations : Explicit methods, implicit methods, one space dimension, two space dimensions.

Elliptic equations: Laplace equation, Poisson equation, iterative schemes.

Computation using MATLAB.

Text Books / Reference Books:

1. G.D. Smith: Numerical solution of Partial Differential equations, Finite Difference methods, Oxford University Press, 1985.
2. M.K. Jain, S.R.K. Iyengar & R.K. Jain: Numerical Methods for Scientific & Engineering Computation, New Age International Publishers, 1996.

3. DR. Lothar Collatz : The numerical treatment of differential equations, Springer-Verlag, New York 1960.
4. K.W. Morton & D.F. Mayers: Numerical solution of Partial differential equations, Cambridge University press. 2005.
5. M.K. Jain : Numerical solution of Differential equations, Wiley Eastern, New Delhi, 1984.

MAL 403 – Numerical Linear Algebra
[(3-0-0); Credit: 3]

Objective: The objective of this subject is to expose student to understand the basic importance of Linear Algebra and numerical linear algebra and its applications to science and engineering.

Course Outcomes (COs):

After completion of this course students will be able to (theoretically and/or numerically)

1) Understand the vector and matrix norms, deal with the Gauss elimination and LU factorization using Gaussian elimination
2) Deal with the LU factorization methods, Conditioning of linear systems
3) Deal with the iteration methods viz., Gauss Jacobi, Gauss-Seidel, SOR and Conjugate gradient methods
4) Deal with the QR factorization and Singular value decomposition (SVD), find least squares solutions and obtain approximation of eigenvalues of a given square matrix.

Content (CO wise):

Special Matrices, Vector and Matrix Norms, SVD. Floating Point Numbers and Errors. Stability, Conditioning and Accuracy. Gauss Elimination and Linear Systems, LU Factorization using Gaussian Elimination, Stability of Gaussian Elimination, Basic Results on Existence and Uniqueness, Some

Applications Giving Rise to Linear Systems of Problems, LU Factorization Methods, Conditioning and Pivoting, Inverses and Determinants. Iterative Methods for Large and Sparse Problems: Gauss Seidal, SOR, Chebyshev Acceleration, Conjugate Gradient Method, Preconditioning. QR Factorization, SVD, and Least Squares Solutions. Numerical Eigenvalue Problems, Generalized Eigenvalue Problem.

Text Books:

1. G. H. Golub and C. F. van Loan: Matrix Computations, Johns Hopkins University Press, 1984.
2. L. N. Trefethen and D. Bau, III: Numerical Linear Algebra, SIAM, 1997.
3. G. Allaire and S. M. Kaber: Numerical Linear Algebra, Springer, 2007.
4. B. N. Datta: Numerical Linear Algebra and Applications, Springer, 2008.

MAL 406– Perturbation Methods
[(3-0-0); Credit: 3]

Objective: The objective of this subject is to expose student to understand the advanced methods to tackle special class of linear and non-linear problems which occur frequently in science and engineering.
Course Outcomes (COs):

Content (CO wise):

Approximate Solution of Linear Differential equations:
Classification of singular points of Homogeneous linear equations, Local behavior near ordinary points of homogeneous linear equations, Local series expansions about regular singular points homogeneous linear equations, Local behavior at irregular singular points of homogeneous linear equations, Irregular singular point at infinity, Local analysis of Inhomogeneous Linear equations, Asymptotic Relations, Asymptotic series.
Approximate Solution of Nonlinear Differential equations:
Spontaneous Singularities, Approximate solutions of first order non-linear equations, Approximate solutions to Higher order nonlinear differential equations, non-linear autonomous systems.
Perturbation Methods
Perturbation theory: elementary introduction, application to polynomial equations and initial value problems for differential equations. Regular and singular perturbation theory: classification of perturbation problems as regular and singular, introductory examples of boundary – layer, WKB and multiple scale problems.
Asymptotic Matching: Matched asymptotic expansions, application to differential equations.

Boundary Layer theory

Introduction to Boundary – Layer theory: Linear and nonlinear examples.

Mathematical Structure of Boundary Layers: Inner, outer and intermediate limits.

Higher order boundary layer theory: Uniformly valid global approximants to simple boundary value problems.

Distinguished Limits and Boundary layers of thickness $\neq \varepsilon$: illustrative examples

Miscellaneous Examples of Linear Boundary Layer problems, Non Linear Boundary Layer problems.

Text Books:

1. Advanced Mathematical methods for Scientists and Engineers by Carl M. Bender & Steven A. Orszag, McGraw Hill International, 1999.
2. Perturbation Methods by Ali Hasan Nayfeh, John Wiley & Sons, New York, 2007.

MAL 407 - Statistics & Optimization Techniques
[(3-0-0); Credit: 3]

Objective: The objective of this subject is to expose student to understand the importance of statistical analysis. It also focuses the optimization techniques to solve linear and nonlinear programming problems.

Course Outcomes (COs):

Content (CO wise):

Statistics -

Sampling Theory: Population Parameter, Sample Statistics, Sampling distributions, Sample mean, Sampling distribution of means, the sample variance, the sampling distribution of variance.

Estimation Theory: Point estimate and interval estimates, reliability, confidence interval estimates of population parameters, confidence intervals for means, proportions and variance.

Tests of Hypothesis and Significance: Statistical decisions, tests of hypotheses and significance, Type I and Type II errors, level of significance, one tailed and two tailed tests. Tests involving small samples and large samples, fitting theoretical distributions to sample frequency distribution, The chi-square test for goodness of fit.

O. R. Techniques-

Linear Programming: Formulation of linear programming problem, Graphical solution- simplex method (including Big M method and two phase method), dual problem- duality theory, dual simplex method, revised simplex method.

Transportation problem: Existence of solution-degeneracy- MODI method; Assignment problem- traveling salesman problem

Nonlinear programming problem (NLPP): Constrained NLPP, Lagrange's multipliers method – convex NLPP, Kuhn-Tucker conditions.

Text Books:

1. M.R. Speigel: Probability and Statistics, McGraw-Hill, 1995.
2. H.A. Taha : Operation Research Prentice Hall of India Pvt. Ltd, 1998.

Reference Books:

1. J.C. Pant, Introduction to Optimization: Operations Research Jain Brothers, New Delhi, 2004.
2. Miller and Freund, Probability and Statistics for Engineers, Economy Edition, PHI, 8th Edition, 2011.

MAL408 - Statistical Analysis & Queuing Theory
[(3-0-0); Credit: 3]

Objective: The objective of this subject is to expose student to understand the importance of statistical analysis. It also focuses on waiting time models.

Course Outcomes (COs):

After completing this course students will

(1) Be exposed to the importance of statistical analysis such as estimation, testing of hypothesis, regression.
(2) Be aware of waiting time models with the use of Bernoulli/Poisson/Renewal process.
(3) Be able to use Markov chains for analysis of queues and birth-death process.
(4) Be able to apply queuing theory models to real life situations.
(5) Be able to use curve fitting methods.

Content (CO wise):

Testing of Hypotheses: Neyman Pearson theory of testing of Hypotheses: Some fundamental notions of hypotheses testing, Neyman Pearson lemma, unbiased and invariant tests, generalized likelihood ratio tests, Chi – Square test, t – tests, F – tests, Bayes and minimax procedures, methods of finding confidence intervals, unbiased and equivariant confidence intervals.

Stochastic Processes: Introduction, classification of stochastic processes, the Bernoulli process, the Poisson process, Renewal process, availability analysis, random incidence, renewal model of program behavior.

Discrete-Parameter Markov Chains: Introduction, computation of n- step transition probabilities, state classification and limiting distributions, distribution of times between state changes, irreducible finite change with A periodic states, the M/G/1 Queuing system, discrete parameter Birth-Death processes, finite Markov chains with absorbing states.

Continuous – Parameter Markov Chains: Introduction, the Birth and death process, other special cases of Birth –death Model, non-Birth-Death processes, Markov chains with absorbing states.

Networks of Queues: Introduction, open queuing networks, closed queuing networks, non-exponential service-time distributions and multiple job types, Non – product- Form Networks.

Regression , correlation and Analysis of Variance: Introduction, Least squares curve fitting, the coefficient of determination, confidence intervals in linear regression, correlation analysis, simple non-linear regression, higher dimensional least squares fit, analysis of variance.

Text books:

1. Vijay K. Rohatgi & A.K. Md. Ehsanes Saleh: An Introduction to Probability and statistics , John Wiley & Sons Inc., New York, 1976.

2. Kishor S. Trivedi : Probability & Statistics with reliability, Queuing and computer Science applications, PHI private Ltd, 2009.

MAL409 - Application of Operational Research Techniques in Construction Management [(3-0-0); Credit: 3]

Objective: The objective of this subject is to expose student to understand the importance of operational research to solve problems related to construction management.

Course Outcomes (COs)
After Completing this course, students will be able to

1. Formulate Linear programming problem of the real life problem occurring in the field of manufacturing and logistics, production planning, Man power problem etc. Formulate Mathematical model and finding optimal solution of Transportation problem, Assignment Problem, Travelling Salesman Problem.
2. Know about Dynamic Programming method and its stage wise solution procedure to solve a problem stage wise.
3. Understand basic of Inventory Management, Sequencing, Game Theory and its real line application in the field of construction management.
4. Deal with Simulation as applied to construction. Modifications and improvements on CPM/PERT techniques applications to construction management.

Content:

Introduction to linear programming, transportation and assignment problems. Dynamic programming waiting line models.

Inventory Management, Sequencing, Decision theory, Game theory, Simulation as applied to construction. Modifications and improvements on CPM/PERT techniques applications to construction management.

Text books:

1. N. D. Vohra : Quantitative Techniques in Management , The Mc. Graw Hill Companies.
2. J.C. Pant, Introduction to Optimisation : Operations Research Jain Brothers, New Delhi.
3. H.M.Wagner : Principles of Operations Research, Prentice Hall of India, New Delhi.
4. Kambo : Mathematical Progamming Techniques, East-West Publishers, New Delhi..

MAL 410 – Introduction to Finite Element Method
[(3-0-0); Credit: 3]

Objective: The objective of this subject is to expose student to understand the importance of finite element methods to tackle the problems of science and engineering.
Course Outcomes (COs):

Content (CO wise):

Introduction to Calculus of Variations.

Finite Element Method: Rayleigh-Ritz minimization - weighted residuals - Galerkin method applied to boundary value problems.

Global and local finite element models in one dimension - derivation of finite element equation.

Finite element interpolation - polynomial elements in one dimension, two dimensional elements, natural coordinates, triangular elements, rectangular elements, Lagrangian and Hermite elements for rectangular elements - global interpolation functions.

Local and global forms of finite element equations - boundary conditions - methods of solution for a steady state problem - Newton-Raphson continuation - one dimensional heat and wave equations.

Text Books/ Reference Book:

1. J.N.Reddy: An introduction to the Finite Element Method, McGraw Hill, New York, 2006.

2. T.J. Chung: Finite element analysis in Fluid Dynamics, McGraw Hill Inc, 1978.