DEPARTMENT OF MATHEMATICS
Punjab Engineering College, Chandigarh
(Deemed to be University)

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Please find attached the syllabi of the following open elective courses and minor specialization courses in Mathematics under the new UG scheme 2023.

OPEN ELECTIVE COURSES

S. No.	Course Code	Course Name	L	T	P	Credits
1.	MCO 1001	Optimization Techniques	3	1	0	4
2.	MCO 1002	Algebra	3	1	0	4
3.	MCO 1003	Number Theory	3	1	0	4
4.	MCO 1004	Fourier Series and Integral Transforms	3	1	0	4
5.	MCO 1005	Algebraic Coding Theory	3	1	0	4
6.	MCO 1006	Topology	3	1	0	4
7.	MCO 1007	Numerical Analysis	3	1	0	4
8.	MCO 1008	Partial Differential Equations and Special Functions	3	1	0	4

MINOR SPECIALIZATION IN MATHEMATICS

S.No.	Course Code	Course Name	L	T	P	Credits
1.	MCM 1001	Operations Research	3	1	0	4
2.	MCM 1002	Complex Analysis	3	1	0	4
3.	MCM 1003	Probability And Statistics	3	1	0	4
4.	MCM 1004	Minor Specialization Project-I*	-	-	-	3
5.	MCM 1005	Minor Specialization Project-II*	-	-	-	3

*The students will be guided for interdisciplinary project.

Course Name	**:**	**OPTIMIZATION TECHNIQUES**
Course Code	**:**	**MCO 1001**
Credits	**:**	**4**
L T P	**:**	**3 1 0**

Course Objectives:
Students should be able - • To develop mathematical model of optimization problems and explore different techniques to solve linear models of optimization • To analyze the extreme values of unconstrained and constrained problems • To apply classical methods to solve non-linear models for optimization problems • To analyze conditions for the optimality of multivariable optimization problems

Total No. of Lectures – 42

Lecture wise breakup		**No. of Lectures**
Unit 1	**Linear Programming:** Formulation, Graphical solution, Simplex method, Relation between graphical and simplex method, Unrestricted variables, Artificial variables, M-method and Dual phase method.	**16**
Unit 2	**Optimization Techniques:** **Unconstrained Problems -** (single and multivariable optimization) necessary and sufficient conditions for extreme points. **Constrained Problems - (**multivariable optimization) Equality constraints - Jacobian and Lagrangian methods, Application of Jacobian method to linear problems. Inequality constraints – extension of Lagrangian method, Karush Kuhn Tucker conditions.	**12**
Unit 3	**Non - Linear Programming:** **Unconstrained Algorithms –** Direct search methods - Dichotomous and Golden search, Univariate and Hooke and Jeeves search methods. Gradient methods - Cauchy's steepest ascent method and Newton's method.	**14**

Course Outcomes:	
1	Analyze the performance of linear and non-linear programming algorithms
2	Explain and implement the graphical solution and simplex method for linear programming problems
3	Apply and compare the Jacobian and Lagrangian methods to solve non-linear programming problems
4	Identify and classify the critical points of the non-linear functions
5	Describe the necessary and sufficient conditions for optimality in non-linear programming

Text Book:	
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication / Reprint**
1	Operations Research, Hamady Taha, 10th edition, Pearson	2017
Reference Books:	
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication / Reprint**
1	Operations Research, Ravindran, Phillips, and Solberg, John Wiley & sons.	2000
2	Engineering Optimization, S S Rao, New Age	2000
3	Operations Research, Kantiswarup, Gupta P.K. & Sultan Chand & Sons.	2007

Equivalent MOOCs courses

Sr. No.	**Course Links**	**Offered by**
1	Operations Research https://nptel.ac.in/courses/111107128	NPTEL
2	Optimization Methods for Civil engineering https://archive.nptel.ac.in/courses/105/103/105103210/	NPTEL

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
CO1	3	1	1	2	1	–	–	–	–	–	2	2	–	–	–
CO2	2	3	1	1	1	–	–	–	–	–	1	2	–	–	–
CO3	3	1	1	1	2	–	–	–	–	–	2	2	–	–	–
CO4	1	3	1	2	1	–	–	–	–	–	1	2	–	–	–
CO5	3	1	2	1	1	–	–	–	–	–	1	2	–	–	–

Course Name	**:**	**ALGEBRA**
Course Code	**:**	**MCO 1002**
Credits	**:**	**4**
L T P	**:**	**3 1 0**

Course Objectives:

Student should be able

- To explore the basic concepts of group theory
- To apply the Lagrange's and Euler's Theorems to solve problems related to groups
- To analyze the normal subgroups, quotient groups, and homomorphisms
- To develop a deep understanding of the fundamental concepts of ring theory

Total No. of Lectures – 42

Lecture wise breakup		**No. of Lectures**
Unit 1	**Introduction to Group:** Definition of a group, Examples, Some preliminary lemmas, Subgroups, Examples, Cosets, Order of a group, Lagrange's theorem, Euler's theorem, A counting principle.	**12**
Unit 2	**Properties of Groups:** Normal subgroups and quotient groups, Homomorphism, Cauchy's theorem, Sylow's theorem for Abelian groups, Permutation groups, Conjugacy classes, Class equation.	**14**
Unit 3	**Rings :** Definition and examples of rings, Subrings, Integral domain, Fields, Characteristic of a ring, Ideals, Factor rings, Prime ideals and maximal ideals. .	**16**

Course Outcomes:	
1	Define and illustrate the concept of groups, subgroups, and cosets
2	Explain the application of Lagrange's theorem in group theory
3	Interpret the significance of normal subgroups, quotient groups, and homomorphisms
4	Analyze the concept of conjugacy classes and class equation
5	Discuss the fundamental concepts of ring theory

Text Books:

Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Topics in Algebra, Herstein, I.N., 2nd edition, Wiley Eastern Limited, New Delhi.	1981
2	Contemporary Abstract Algebra, Joseph A. Gallian, (4th Edition), Narosa Publishing House, New Delhi	1999

Reference Books:

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1	Modern Algebra, Singh, S and Zameeruddin, Q ,Vikas Publishing House, New Delhi	2015
2	Rings and Modules, Musili, C, Narosa Publishing House, (2nd Edition), New Delhi.	1997

Equivalent MOOCs courses

Sr. No.	Course Links	Offered by
1	Introduction to abstract and linear algebra, https://archive.nptel.ac.in/courses/111/105/111105112/#	NPTEL
2	Introduction to abstract group theory, https://archive.nptel.ac.in/courses/111/106/111106113/	NPTEL

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	2	3	1	2	1	–	–	–	–	–	2	2	–	–	–
CO2	3	1	1	2	1	–	–	–	–	–	1	1	–	–	–
CO3	2	3	1	1	2	–	–	–	–	–	1	1	–	–	–
CO4	2	3	1	2	1	–	–	–	–	–	2	1	–	–	–
CO5	3	1	2	1	1	–	–	–	–	–	1	1	–	–	–

Course Name	**:**	**NUMBER THEORY**
Course Code	**:**	**MCO 1003**
Credits	**:**	**4**
L T P	**:**	**3 1 0**

Course Objectives:

Students should be able –

- To develop a deep understanding of number theory, including divisibility, greatest common divisor, Euclidean algorithm, primes, and fundamental theorem of arithmetic
- To analyze and solve congruences, including residue classes, reduced residue classes, Fermat's theorem, Euler's theorem, Wilson's theorem, and Chinese remainder theorem
- To explore the concepts of congruences of higher degree, prime power modulii, prime modulus, primitive roots, indices, power residues, quadratic residues, quadratic reciprocity, and Jacobi symbols
- To apply the concepts of number theory to solve Diophantine equations and other problems in mathematics and computer science

Total No. of Lectures – 42

Lecture wise breakup		**No. of Lectures**
Unit 1	**Basic Properties of Integers:** Introduction, Divisibility, Greatest common divisor, The Euclidean algorithm, Primes, Fundamental theorem of arithmetic.	**8**
Unit 2	**Congruences of Degree One:** Congruences, Residue classes and reduced residue classes, Fermat's theorem, Euler's theorem, Wilson theorem, Solution of congruences, Congruences of degree 1, Chinese remainder theorem with applications. Euler's φ-function.	**12**
Unit 3	**Congruences of Higher Degree :** Congruences of higher degree, Prime power moduli, Prime modulus, Primitive roots, Indices and their applications, power residues, Quadratic residues, Quadratic reciprocity, Legendre symbol, Euler's criterion, Gauss's lemma, Quadratic reciprocity law, Jacobi symbol.	**12**
Unit 4	**Diophantine Equations :** Greatest integer function, Arithmetic function, Mobius inversion formula, Diophantine equations.	**10**

Course Outcomes:	
1	Define and explain the key concepts of number theory, including divisibility, Euclidean algorithm, primes, fundamental theorem of arithmetic, congruences, residue classes, Fermat's theorem, Euler's theorem, Wilson's theorem, quadratic reciprocity law, etc.
2	Explain the relationship between the different concepts in number theory, such as how congruences are related to residue classes and how quadratic reciprocity is related to power residue
3	Define and apply the concepts of greatest integer function, arithmetic functions Möbius inversion formula to prove number-theoretic identities

4	Apply the Chinese remainder theorem to solve a system of linear congruences, the quadratic reciprocity law to determine the solvability of a quadratic congruence and Euler's theorem to solve a problem in modular arithmetic
5	Define and apply the basic concepts of number theory, including divisibility, greatest common divisor, prime numbers, and the Fundamental theorem of arithmetic

Text Book:		
Sr.No	**Name of Book/ Authors/ Publisher**	**Year of Publication / Reprint**
1	An introduction to theory of numbers, Niven I., Zuckerman S. H. and Montgomary L. H. 5th edition, John Wiley and Sons.	1991
Reference Books:		
Sr.No	**Name of Book/ Authors/ Publisher**	**Year of Publication / Reprint**
1	Introduction to Theory of Numbers, Hardy and Wright W. H. Oxford University Press	2008
2	Higher Arithmetic, Davenport H. 8th edition, Cambridge University Press.	2008
3	Elementary Number Theory, David M. Burton, McGraw-Hill Higher Education	2010

Equivalent MOOCs courses

Sr.No	**Course Links**	**Offered by**
1	A basic course in number theory https://archive.nptel.ac.in/courses/111/101/111101137/	NPTEL
2	Number Theory https://archive.nptel.ac.in/courses/111/103/111103020/	NPTEL

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
CO1	2	3	1	2	1	–	–	–	–	–	2	2	–	–	–
CO2	3	2	1	1	1	–	–	–	–	–	1	2	–	–	–
CO3	1	3	1	1	2	–	–	–	–	–	2	1	–	–	–
CO4	3	2	1	2	1	–	–	–	–	–	1	2	–	–	–
CO5	3	1	2	1	1	–	–	–	–	–	2	3	–	–	–

Course Name	**:**	**FOURIER SERIES AND INTEGRAL TRANSFORMS**
Course Code	**:**	**MCO 1004**
Credits	**:**	**4**
L T P	**:**	**3 1 0**

Course Objectives:

Students should be able

- To develop a comprehensive understanding of periodic functions, trigonometric series, and Fourier series
- To apply the knowledge of Fourier series and Fourier integrals in approximating functions by trigonometric polynomials
- To explore the principles and applications of Fourier transforms, including Fourier Cosine and Sine transforms, and the properties associated with them
- To analyze the Laplace transforms to solve differential and integral equations using techniques such as s-shifting, t-shifting, and the convolution theorem

Total No. of Lectures – 42

Lecture wise breakup		**No. of Lectures**
Unit 1	**Fourier Series:** Periodic functions, Trigonometric series, Fourier series, Euler's formula, Conditions for existence of Fourier series, Functions of any period p = 2L, Even and odd functions, Half range expansions, Complex Fourier series, Applications of Fourier series, Parseval's identity, Harmonic analysis, Approximation by trigonometric polynomials.	**12**
Unit 2	**Fourier Transforms and Their Properties:** Fourier integral, Fourier Sine and Cosine integrals, Evaluation of integrals, Fourier transforms, Fourier Cosine and Sine transforms, Properties of Fourier transform, Linearity and symmetry, Change of time scale, Time shifting, Frequency shifting, Fourier transform of derivatives and integrals.	**18**
Unit 3	**Laplace Transforms, Properties and Applications:** Laplace transform, Inverse transform, Properties of Laplace transform, Transforms of derivatives and integrals, s-Shifting, t-Shifting, Unit step function, Dirac's delta function, Differentiation and integration of transforms, Convolution theorem - Applications to differential and integral equations.	**12**

Course Outcomes:	
1	Define and recognize the concepts of periodic functions, trigonometric series, and Fourier series
2	Analyze functions of any period and apply half-range expansions and harmonic analysis
3	Synthesize knowledge of Fourier cosine and sine integrals and their evaluation techniques
4	Apply the knowledge of Laplace transform to solve differential and integral equations arising in engineering problems

Text Book:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Advanced Engineering Mathematics Erwin Kreyszig, John Wiley, 10th edition	2011
Reference Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Higher Engineering Mathematics, B V Ramana, Tata McGraw -Hill	2008
2	Advanced Engineering Mathematics, Wylie and Barrett, McGraw Hill.	2003
3	Integral transforms and their Applications, L. Debnath, CRC Press, New York London- Tokyo	1995

Equivalent MOOCs courses

Sr. No.	**Course Links**	**Offered by**
1	Transform Calculus and Its Applications In Differential Equation, https://archive.nptel.ac.in/courses/111/105/111105123/	NPTEL
2	Integral Transforms and their Applications, https://archive.nptel.ac.in/courses/111/102/111102129/	NPTEL

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS 02**	**PS O3**
CO1	2	3	1	1	1	–	–	–	–	–	2	2	–	–	–
CO2	3	2	1	1	1	–	–	–	–	–	1	2	–	–	–
CO3	1	3	1	1	2	–	–	–	–	–	1	1	–	–	–
CO4	1	3	2	2	1	–	–	–	–	–	3	3	–	–	–

Course Name	**:**	**ALGEBRAIC CODING THEORY**
Course Code	**:**	**MCO 1005**
Credits	**:**	**4**
L T P	**:**	**3 1 0**

Course Objectives:

Students should be able

- To explore the foundational concepts of source and channel coding
- To develop the understanding of finite fields and polynomial rings
- To explore the concepts of linear codes
- To apply the theory of cyclic codes to solve problems related to coding theory

Total No. of Lectures – 42

Lecture wise breakup		**No. of Lectures**
Unit 1	**Introduction to Coding Theory:** Source and Channel coding, Error detecting and error correcting codes.	2
Unit 2	**Error Detection, Error Correction and Decoding:** Communication Channels, Maximum likelihood decoding, Hamming distance, Nearest neighbour / minimum distance decoding, Distance of a code.	6
Unit 3	**Finite Fields:** Fields, Polynomial rings, Structure of finite fields, Minimal polynomials.	10
Unit 4	**Linear Codes:** Vector spaces over finite fields, Linear Codes, Hamming weight, Bases for linear codes Generator matrix and parity check matrix, Equivalence of linear codes, Encoding with a linear code, Decoding of linear codes, Cosets, Nearest neighbor decoding for linear codes, Syndrome decoding, Weight enumerator of a Code, Macwilliam's identity**.**	16
Unit 5	**Cyclic Codes:** Generator polynomials, Generator matrix and parity check matrix, Decoding of linear codes.	8

Course Outcomes:	
1	Define and comprehend the concepts of source and channel coding
2	Execute knowledge of finite fields, polynomial rings, and the structure of finite fields to solve coding theory problems
3	Analyze linear codes and their properties, including the Hamming weight, generator matrix, parity check matrix
4	Apply the concepts of cyclic codes, including the understanding of generator polynomials

Text Book:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Coding Theory, San Ling & Chaoping Xing, Cambridge University Press.	2010
Reference Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Introduction to the 'Theory of Error Correcting Codes, Vera Pless, Cambridge University Press.	2003
2	Introduction to Error Correcting Codes, Raymond Hill, Clarendon Press, Oxford.	1986
3	Theory of Error Correcting Codes Part I & II, F.J.Macwilliams & NJA Sloane.	1977

Equivalent MOOCs courses

Sr. No.	**Course Links**	**Offered by**
1	An Introduction to Coding Theory, https://onlinecourses.nptel.ac.in/noc20_ee94/preview	NPTEL
2	Coding theory, https://archive.nptel.ac.in/courses/117/106/117106031/	NPTEL

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
CO1	2	3	1	2	1	–	–	–	–	–	2	2	–	–	–
CO2	3	2	1	1	1	–	–	–	–	–	1	1	–	–	–
CO3	2	3	1	1	1	–	–	–	–	–	1	1	–	–	–
CO4	3	1	1	2	2	–	–	–	–	–	2	3	–	–	–

Course Name	**:**	**TOPOLOGY**
Course Code	**:**	**MCO 1006**
Credits	**:**	**4**
L T P	**:**	**3 1 0**

Course Objectives:

Students should be able

- To develop a comprehensive understanding of topological spaces and its properties
- To explore the concept of continuous mappings on a topological space
- To analyze the notions of connectedness, path-connectedness, and local connectedness in relation to the continuity of functions
- To apply the principles of compactness and separation axioms to solve problems related to topological spaces

Total No. of Lectures – 42

Lecture wise breakup		**No. of Lectures**
Unit 1	**Introduction to Topological Concepts**: Topological spaces, Basis, Subbases, Open sets, Closed sets, Limit point, Closure of a set and its properties, Neighborhood of a point, Neighborhood axioms, Boundary of a set, Creating new topology, The subspace topology, Quotient topology, Product topology.	12
Unit 2	**Continuous Maps and Their Properties:** Alternative method of defining topology in terms of Kuratowski closure operator, First and second countable spaces, Separable spaces, Continuous maps, Closed maps and their characterizations, Homeomorphisms.	12
Unit 3	**Topological Properties:** Connectedness, Connected components, Path connectedness, Local connectedness, Continuity and connectedness. Compactness, Basic properties of compactness, One point compactification, Finite intersection property, B-W compactness. Countable compactness, Lindelof spaces.	12
Unit 4	**Separation Axioms:** T_0,T_1,T_2,T_3,T_4, Regular, Normal, Completely regular and their properties.	6

Course Outcomes:	
1	Define and illustrate the concepts of topological spaces, and their basic elements
2	Explain the properties of closed sets, limit points, and neighborhoods in the context of topological spaces
3	Analyze the role of continuous maps, closed maps, and homeomorphisms in the context of topological spaces
4	Interpret the principles of compactness, separation axioms, and their properties

Text Book:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication / Reprint**
1	General Topology, S.Willard, Dover publications.	2012
2	Foundations of General Topology, William J. Pervin and Ralph P. Boas (Auth.), Elsevier Inc	1964
3	Topology, J.R. Munkres, 2nd edition, Pearson education	2003
Reference Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication / Reprint**
1	General Topology, J.L.Kelly, Springer.	1975
2	Counter Examples in Topology, L.A.Steen & J.A. Seebach, (2^{nd} ed.) Dover Publications.	1995
3	Topology For Analysis,A.Wilansky:Toronto:Xerox College Publishing.	1970

Equivalent MOOCs courses

Sr. No.	**Course Links**	**Offered by**
1	Topology https://nptel.ac.in/courses/111106054	NPTEL
2	An invitation to topology https://nptel.ac.in/courses/111106159	NPTEL

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
CO1	2	3	1	2	1	–	–	–	–	–	2	2	–	–	–
CO2	3	2	1	1	1	–	–	–	–	–	1	1	–	–	–
CO3	1	3	1	1	2	–	–	–	–	–	2	1	–	–	–
CO4	2	3	1	2	1	–	–	–	–	–	1	1	–	–	–

Course Name	**:**	**NUMERICAL ANALYSIS**
Course Code	**:**	**MCO 1007**
Credits	**:**	**4**
L T P	**:**	**3 1 0**

Course Objectives:

Students should be able –

- To develop a deep understanding of the theoretical foundations of numerical methods, including the concepts of convergence, stability, and accuracy
- To analyze the different types of errors in numerical calculations and their effects on the accuracy of results
- To explore methods and algorithms for reducing and controlling errors in numerical calculations
- To analyze the accuracy of different interpolation and numerical differentiation and integration methods, and identify the most appropriate method to use for a given problem
- To apply different numerical methods to solve algebraic and transcendental equations

Total No. of Lectures – 42

Lecture wise breakup		**No. of Lectures**
Unit 1	**Errors:** Errors in numerical calculations, Absolute, Relative and percentage errors, Round off and truncation errors, Error propagation, Loss of significant digits, Errors in series approximation, Speed of convergence.	5
Unit 2	**Root Finding Methods:** Bisection method, Regula-Falsi , Fixed point iteration and its convergence, Newton-Raphson, Acceleration of convergence using Aitken's method; Generalized Newton's	7
Unit 3	**Solution of Linear System of Equations:** Direct methods - Gauss elimination, Partial pivoting, Complete pivoting, Gauss-Jordan and factorization methods, Iterative methods- Gauss Seidal and Jacobi's methods.	6
Unit 4	**Interpolation:** Lagrange Interpolation, Newton's divided difference interpolation, Finite differences, Newton's, Bessel's, Errors.	10
Unit 5	**Numerical Differentiation and Integration:** Differentiation using differences, Integration using Newton-cote's formulas with errors, Gaussian Quadrature.	8
Unit 6	**Numerical Methods for Differential Equations:** Solution of first order differential equations using Taylor's series, Euler's, Picard's and Runge-Kutta method upto 4^{th} order, Predictor-Corrector methods (Adam's and Milne's method).	6

Course Outcomes:	
1	Define and explain the key concepts of numerical methods, including errors, convergence, stability, and accuracy

2	Describe the different numerical methods for solving non-linear equations, interpolation, numerical differentiation and integration, and differential equations
3	Explain how to compute the absolute, relative, and percentage errors of a numerical calculation
4	Compare and contrast different numerical methods for solving a given problem
5	Identify the most appropriate numerical method to use for a given problem, taking into account the desired accuracy, computational cost, and other factors

Text Book:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication / Reprint**
1	Numerical Methods for Mathematics, Science and Engineering, John H. Mathews, Prentice Hall.	1992
2	Numerical Methods for Engineers, Steven C. Chapra, Raymond P. Canale, McGraw-Hill.	2014
Reference Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication / Reprint**
1	Advanced Engineering Mathematics, E. Kreyszig, John Wiley.	2006
2	An Introduction to Numerical Analysis, Atkinson, John Wiley.	2012
3	Numerical Methods, Jain, S R K Lyengar R K, New Age international Publishers.	2009

Equivalent MOOCs courses

Sr. No.	**Course Links**	**Offered by**
1	Numerical Analysis https://archive.nptel.ac.in/courses/111/107/111107062	NPTEL
2	Numerical Analysis https://archive.nptel.ac.in/courses/111/101/111101165/	NPTEL

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
CO1	2	3	1	2	1	–	–	–	–	–	2	2	–	–	–
CO2	3	2	1	1	1	–	–	–	–	–	1	1	–	–	–
CO3	2	3	1	1	1	–	–	–	–	–	2	3	–	–	–
CO4	3	1	1	2	2	–	–	–	–	–	1	1	–	–	–
CO5	3	2	1	1	1	–	–	–	–	–	2	2	–	–	–

Course Name	**:**	**PARTIAL DIFFERENTIAL EQUATIONS AND SPECIAL FUNCTIONS**
Course Code	**:**	**MCO 1008**
Credits	**:**	**4**
L T P	**:**	**3 1 0**

Course Objectives:

Students should be able –

- To develop a deep understanding of the theoretical foundations of partial differential equations and special functions
- To analyze the different types of partial differential equations and their properties
- To explore methods for solving partial differential equations and series solutions to differential equations
- To analyze the behavior of special functions, such as Legendre polynomials and Bessel functions
- To explore the applications of partial differential equations and special functions in science and engineering

Total No. of Lectures – 42

Lecture wise breakup		**No. of Lectures**
Unit 1	**Partial Differential Equations:** Introduction and formation of first order partial differential equations, Method of characteristic and general solution of first order PDE, Method of separation of variables for first order PDE, Classification of quasilinear second order PDE, Linear equations of second order with constant coefficients, Applications to engineering problems**.**	**17**
Unit 2	**Special Functions:** Singular points, Series solution of differential equations, Power series methods, Series solution of Legendre's differential equation, Generating functions, Legendre's polynomial, Recurrence relations, Frobenius method, Series solution of Bessel's differential equation, Bessel's functions, Modified Bessel's functions, Recurrence relations, Equations reducible to Bessel's equation.	**25**

Course Outcomes:	
1	Define and explain the key concepts of partial differential equations and special functions, such as first-order PDEs, linear PDEs with constant coefficients, Legendre polynomials, and Bessel functions
2	Explain how to form and solve first-order partial differential equations
3	Describe the properties of Legendre polynomials and Bessel functions, such as their orthogonality and asymptotic behaviour
4	Identify the different types of partial differential equations and describe the series solution method for solving differential equations
5	Analyse the convergence of series solutions to differential equations and behavior of Legendre polynomials and Bessel functions under different conditions

Text Book:		
Sr.No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Advanced Engineering Mathematics, E. Kreyszig, John Wiley.	2006
Reference Books:		
Sr.No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Elements of Partial differential equations, Sneddon, McGraw Hill.	2006
2	Higher Engineering Mathematics, B. V. Ramana, McGraw Hill.	2008
3	Advanced Engineering Mathematics, Wylie and Barrett, McGraw Hill.	2003

Equivalent MOOCs courses

Sr. No.	Course Links	Offered by
1	Partial Differential Equations https://archive.nptel.ac.in/courses/111/101/111101153/	NPTEL
2	Ordinary and Partial Differential Equations and Applications https://archive.nptel.ac.in/courses/111/107/111107111/	NPTEL

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**	**PSO3**
CO1	2	3	1	2	1	–	–	–	–	–	2	2	–	–	–
CO2	3	2	1	2	1	–	–	–	–	–	1	1	–	–	–
CO3	3	2	1	1	1	–	–	–	–	–	1	1	–	–	–
CO4	1	3	1	1	2	–	–	–	–	–	1	1	–	–	–
CO5	3	2	1	1	1	–	–	–	–	–	1	2	–	–	–

Course Name	**:**	**OPERATIONS RESEARCH**
Course Code	**:**	**MCM 1001**
Credits	**:**	**4**
L T P	**:**	**3 1 0**

Course Objectives:

Students should be able

- To analyze the characteristics and scope of operations research
- To explore different linear models of optimization problems
- To develop, formulate, and solve problems of transportation and assignment model
- To apply the theory of queuing models to address issues in real world problems
- To explore and deal with non-linear programming problems

Total No. of Lectures – 42

Lecture wise breakup		**No. of Lectures**
Unit 1	**Introduction to Operations Research:** Definition of operations research, Characteristics of operations research, Scope of operations research.	**3**
Unit 2	**Linear Programming:** Formulation of linear programming problem, Graphical solution, Simplex method, Unrestricted variables, Artificial variables, M-Method, Two phase method, Duality.	**17**
Unit 3	**Transportation Models:** Introduction to the transportation model, Assumption in the transportation model, Definition of the transportation model, Matrix terminology, Formulation and solution of transportation model, Assignment model.	**10**
Unit 4	**Queueing Theory:** Queuing model: Introduction, Application of queuing model, Elements of queuing system, Operating characteristics of queuing system, Waiting time and idle time costs, Random variable, Poisson and exponential distribution.	**12**

Course Outcomes:	
1	Describe the characteristics of operations research and identify its scope in real-world problems
2	Formulate and solve linear models of optimization problems using graphical and simplex method
3	Understand the transportation and assignment models and evaluate their solutions
4	Analyze the performance of queuing systems using different metrics
5	Explain the necessary and sufficient conditions for optimality in non-linear programming

Text Book:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication / Reprint**
1	Operations Research, Taha, H.A, 10th edition, Pearson.	2017
2	Operations Research, Ravindran, Phillips, and Solberg, 2nd edition, John Wiley & sons.	2000
3	Engineering Optimization, S S Rao, 4nd edition, New Age.	2009
Reference Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication / Reprint**
1	Operations Research, Kantiswarup, Gupta P.K. & Sultan Chand & Sons.	2007
2	Operations Research, Sharma S.D., Kedarnath, Ramnath & Company.	1994
3	Operations Research, Bronson R, Shaum's Outline Series.	1997

Equivalent MOOCs courses

Sr. No.	**Course Links**	**Offered by**
1	Operations Research https://nptel.ac.in/courses/111107128	NPTEL
2	Optimization methods for Civil engineering https://archive.nptel.ac.in/courses/105/103/105103210/	NPTEL
3	Advanced Operations Research https://nptel.ac.in/courses/112106131	NPTEL

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
CO1	2	3	1	2	1	–	–	–	–	–	2	2	–	–	–
CO2	3	2	1	1	1	–	–	–	–	–	2	2	–	–	–
CO3	1	3	1	1	2	–	–	–	–	–	1	2	–	–	–
CO4	2	3	1	2	1	–	–	–	–	–	2	1	–	–	–
CO5	3	1	2	1	1	–	–	–	–	–	2	2	–	–	–

Course Name	**:**	**COMPLEX ANALYSIS**
Course Code	**:**	**MCM 1002**
Credits	**:**	**4**
L T P	**:**	**3 1 0**

Course Objectives:

Student should be able:

- To explore the basic ideas of complex analysis
- To analyze the basic theory of functions of a complex variable
- To apply the techniques of complex analysis in solving integration problems
- To apply the concept of conformal mappings to solve specific formulated engineering problems

Total No. of Lectures – 42

Lecture wise breakup		**No. of Lectures**
Unit 1	**Introduction to Complex Analysis:** Introduction to complex numbers, Functions of complex variables, Exponential function, Trigonometric and hyperbolic functions, Euler's formula, Logarithm.	8
Unit 2	**Functions of Complex Variables:** Limit and continuity of complex functions, Analytic function, Cauchy–Riemann equations, Laplace's equation, Line integral in the complex plane, Cauchy's integral theorem, Cauchy's integral formula, Derivatives of analytic functions.	12
Unit 3	**Power Series :** Power series, Taylor and Maclaurin series, Laurent Series, Singularities and zeros, Residue integration method, Residue integration of real integrals.	10
Unit 4	**Conformal Mappings:** Conformal mapping, Linear fractional transformations (Möbius transformations), Special linear fractional transformations, Conformal mapping by other functions, Applications of complex analysis in engineering.	12

Course Outcomes:	
1	Discuss the fundamental concepts of complex analysis
2	Illustrate the basic techniques involved in calculus of functions of complex variables
3	Calculate line integration and real integrals via residue calculus
4	Analyze power series and singularities in complex functions
5	Synthesize knowledge of conformal mapping for practical engineering applications

Text Book:

Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Advanced Engineering Mathematics, Erwin Kreyszig, John Wiley, 10th edition	2011

Reference Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Complex Variables and Applications, Ruel V. Churchill and James Ward Brown, McGraw-Hill Publishing Company 8th edition	2009
2	A First Course in Complex Analysis with Applications, Dennis G. Zill and Patrick D. Shanahan, Jones and Bartlett Publishers, 2nd edition	2010
3	Complex analysis, Joseph Bak and Donald J. Newman, Springer-Verlag New York, Inc., New York, 2nd edition.	1997

Equivalent MOOCs courses

Sr. No.	**Course Links**	**Offered by**
1	Complex analysis, https://archive.nptel.ac.in/courses/111/103/111103070/	NPTEL
2	Complex analysis, https://archive.nptel.ac.in/courses/111/106/111106141/	NPTEL

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
CO1	3	2	1	2	1	–	–	–	–	–	2	2	–	–	–
CO2	3	2	1	1	2	–	–	–	–	–	1	1	–	–	–
CO3	1	3	1	2	2	–	–	–	–	–	1	1	–	–	–
CO4	2	3	1	2	1	–	–	–	–	–	2	3	–	–	–
CO5	3	1	2	1	1	–	–	–	–	–	1	1	–	–	–

Course Name	**:**	**PROBABILITY AND STATISTICS**
Course Code	**:**	**MCM 1003**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives

Students should be able –

- To develop a deep understanding of the theoretical foundations of random variables and probability theory
- To analyze the different types of probability distributions and their properties.
- To explore random variables in statistics, machine learning, and other fields
- To apply statistical estimation procedures to estimate population parameters from sample data
- To apply the central limit theorem to construct confidence intervals and hypothesis tests for population parameters

Total No. of Lectures – 42

Lecture wise breakup		**No. of Lectures**
Unit 1	**Random Variables:** Random variables, Discrete, Continuous, Expectation, Variance, Moments, Moment generating function, Binomial, Poisson, Uniform and Normal distributions, Normal and Poisson approximations to Binomial.	**10**
Unit 2	**Joint Probability Distributions:** Joint Probability distributions, Marginal and Conditional distributions, Independent random variables, Covariance, Means and variances of linear combinations of random variables, Chebyshev's inequality.	**10**
Unit 3	**Sampling Distributions:** Population, Sample, Sampling distributions, Central limit theorem, Distribution of sample mean, Difference of means, Proportions and difference of proportions, Chi-square distribution, Student's t-distribution.	**7**
Unit 4	**Estimation:** Estimation of parameters, Point estimate, Confidence interval for mean, Difference of means and proportions.	**6**
Unit 5	**Tests of Hypotheses:** Hypothesis, Test statistic, Critical region, Significance level, Single Sample and two samples tests for mean and proportion.	**9**

Course Outcomes:	
1	Define and explain the key concepts of random variables and probability theory, including discrete and continuous random variables, probability distributions, expectation, variance, and covariance
2	State the different types of hypothesis tests and estimation procedures, and identify the appropriate test or procedure to use for a given problem
3	Calculate the expectation, variance, and covariance of random variables
4	Apply the central limit theorem to construct confidence intervals and hypothesis tests for population parameters

Text Book:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Probability and statistics for Engineers and Scientists, Walpole, Myers, Myers and Ye, 7th edition, Pearson Education	2006
Reference Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Miller and Freund's: Probability and Statistics for Engineers, Richard A. Johnson, C.B. Gupta, Pearson Education.	2006
2	John E. Freund's: Mathematical statistics with Application, Miller and Miller, Pearson Education.	2004
3	A First Course in Probability, Sheldon Ross, 6th edition, Pearson Education Asia	2002

Equivalent MOOCs courses

Sr. No.	**Course Links**	**Offered by**
1	Probability Theory and Applications https://nptel.ac.in/courses/111104079	NPTEL
2	Introduction to Probability Theory and Statistics https://nptel.ac.in/courses/111102160	NPTEL

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
CO1	2	3	1	2	1	–	–	–	–	–	2	2	–	–	–
CO2	3	1	1	2	1	–	–	–	–	–	3	2	–	–	–
CO3	2	3	1	1	1	–	–	–	–	–	2	1	–	–	–
CO4	3	2	1	2	2	–	–	–	–	–	3	3	–	–	–