Course Structure and Syllabus of 04 years B. Sc. (Hons.) in Mathematics with Multiple Entry-Exit Options

Under National Education Policy 2020
(as per the Curriculum and Credit framework for Undergraduate Programmes by UGC, New Delhi)

With effect from: 2024-25

Department of Mathematics
Guru Ghasidas Vishwavidyalaya, Bilaspur
(A Central University)
Bilaspur - 495009, Chhattisgarh, India

Guru Ghasidas Vishwavidyalaya, Bilaspur
Department of Mathematics
B. Sc. (Hons.) Mathematics, Academic Year : 2024-2025

Sem	Courses	Course Code	Paper Name & Number of Courses	Level	Credits	Credits (L+T+P)	Int. Marks	Ext. Marks	Totals
I	**Major-1**		**Algebra & Geometry**	2	**4**	(3-1-0)	30	70	100
	Minor-1		Opted from the Pool Courses offered by University	2	**4**	(3-1-0)	30	70	100
	Multidisciiplinary-1		Opted from the Pool Courses offered by University	1	**3**	(2-1-0)	30	70	100
	AEC-1		Opted from the Pool Courses offered by University	1	**2**	(2-0-0)	30	70	100
	SEC-1		Opted from the Pool Courses offered by University	1	**3**	(2-1-0)	30	70	100
	VAC-1		Opted from the Pool Courses offered by University	1	**2**	(2-0-0)	30	70	100
	VAC-2		Opted from the Pool Courses offered by University	1	**2**	(2-0-0)	30	70	100
			Total		**20**				**700**
II	**Major-2**		**Elementary Analysis**	2	**4**	(3-1-0)	30	70	100
	Minor-2		Opted from the Pool Courses offered by University	2	**4**	(3-1-0)	30	70	100
	Multidisciiplinary-2		Opted from the Pool Courses offered by University	1	**3**	(2-1-0)	30	70	100
	AEC-2		Opted from the Pool Courses offered by University	1	**2**	(2-0-0)	30	70	100
	SEC-2		Opted from the Pool Courses offered by University	1	**3**	(2-1-0)	30	70	100
	VAC-1		Opted from the Pool Courses offered by University	1	**2**	(2-0-0)	30	70	100
	VAC-2		Opted from the Pool Courses offered by University	1	**2**	(2-0-0)	30	70	100
			Total		**20**				**700**
III	**Major-3**		**Ordinary Differential Equations**	3	**4**	(3-1-0)	30	70	100
	Major-4		**Abstract Algebra**	3	**4**	(3-1-0)	30	70	100
	Minor-3		Opted from the Pool Courses offered by University	3	**4**	(3-1-0)	30	70	100
	Multidisciiplinary-3		Opted from the Pool Courses offered by University	1	**3**	(2-1-0)	30	70	100
	AEC		Opted from the Pool Courses offered by University	1	**2**	(2-0-0)	30	70	100
	SEC		Opted from the Pool Courses offered by University	1	**3**	(2-1-0)	30	70	100
			Total		**20**				**600**

IV	**Major-5**		**Advanced Analysis**	3	**5**	(4-1-0)	30	70	100
	Major-6		**Multivariable & Vector Calculus**	3	**4**	(3-1-0)	30	70	100
	Major-7		**Linear Programming & Game Theory**	3	**5**	(4-1-0)	30	70	100
	Minor-4		Opted from the Pool Courses offered by University	3	**4**	(3-1-0)	30	70	100
	AEC		Opted from the Pool Courses offered by University	1	**2**	(2-0-0)	30	70	100
			Total		**20**				**500**

COURSES OFFERED BY THE DEPARTMENT OF MATHEMATICS

Sem.	Courses	Course Code	Number of Courses	Level	Credits	Credits (L +T + P)	Int. Marks	Ext. Marks	Totals
I	Minor-1		Geometry	**2**	**4**	(3-1-0)	30	70	100
	Multidisciipli nary-1		Basics of Statistics	**1**	**3**	(2-1-0)	30	70	100
			Introduction to Calculus	1	**3**	(2-1-0)	30	70	100
	AEC-1		Set, Matrix and Theory of	1	**2**	(2-0-0)	30	70	100
	SEC-1		Number System	1	**3**	(2-1-0)	30	70	100
	VAC-1		Laplace Transformation	1	**2**	(2-0-0)	30	70	100
			Geometry in India-I	1	**2**	(2-0-0)	30	70	100
II	Minor-2		Algebra and Matrix Theory	2	**4**	(3-1-0)	30	70	100
	Multidisciipli nary-2		Curve Tracing	1	**3**	(2-1-0)	30	70	100
			Interpolation	1	**3**	(2-1-0)	30	70	100
	AEC-2		Special Function	1	**2**	(2-0-0)	30	70	100
	SEC-2		Linear Programming Problem	1	**3**	(2-1-0)	30	70	100
	VAC-3		Quantitative Techniques	1	**2**	(2-0-0)	30	70	100
			Geometry in India-II	1	**2**	(2-0-0)	30	70	100
III	Minor-3		Differential Calculus	3	**4**	(3-1-0)	30	70	100
	Multidisciipli		Numerical Methods	1	**3**	(2-1-0)	30	70	100
	AEC-3		Vedic Mathematics	1	**2**	(2-0-0)	30	70	100
	SEC-3		Boolean Algebra	1	**3**	(2-1-0)	30	70	100
IV	Minor-4		Vector Calculus	3	**4**	(3-1-0)	30	70	100
	AEC-4		Basics of Probability	1	**2**	(2-0-0)	30	70	100

Sem	Code	Subject	Periods			Evaluation Scheme				Credit
			L	T	P	Internal Assessment		ESE	Total	
						CT-1	CT-2			
B.Sc. I		Algebra and Geometry (Major-1)	3	1	-	15	15	70	100	4

Algebra and Geometry

Course Objectives: This course will enable the students-

1. To understand the importance of roots of real and complex polynomials and learn various methods of obtaining roots.
2. To familiarize with relations, equivalence relations and partitions. Employ De-Moivre's theorem in a number of applications to solve numerical problems.
3. To recognize consistent and inconsistent systems of linear equations by the row echelon form of the augmented matrix using rank. Find eigenvalues and corresponding eigenvectors for a square matrix.
4. To explain the geometry of straight line, plane and sphere.
5. To explain the properties with geometrical interpretation of three-dimensional shapes.

Unit-I: Theory of Equations and Complex Numbers
Elementary theorems on the roots of an equations including Cardan's method, The remainder and factor theorems, Synthetic division, Factored form of a polynomial, The Fundamental theorem of algebra, Relations between the roots and the coefficients of polynomial equations, reciprocal equations, Imaginary roots, Integral and rational roots; Polar representation of complex numbers, nth roots of unity, De Moivre's theorem for integer and rational indices and its applications.

Unit-II: Relations and Basic Number Theory
Relations, Equivalence relations, Equivalence classes; Functions, Composition of functions, Inverse of a function, division algorithm, Divisibility and Euclidean algorithm, fundamental theorem of arithmetic, Modular arithmetic and basic properties of congruences; Principles of mathematical induction and well ordering, Chinese remainder theorem.

Unit-III: Matrices and Applications
Determinants, Matrix operations, Rank of a matrix, Normal form of matrix, Inverse of a matrix, Row reduction and echelon forms, Linear independence and dependence, Solution of the Systems of linear equations, Characterizations of invertible matrices, Applications to Computer Graphics, Eigen values and eigen vectors, Cayley Hamilton theorem, Reduction to diagonal form, Reduction of quadratic form to canonical form, Complex matrices.

Unit-IV: Planes, Straight Lines, Spheres and Conic section
Planes, Distance of a point from a plane, Angle between two planes, Pair of planes, Bisectors of angles between two planes, Straight lines, Equations of straight lines, Distance of a point from a straight line, Distance between two straight lines, Distance between a straight line and a plane, Spheres, Different forms. Intersection of two spheres, Orthogonal intersection, Tangents and normal, Conic section, cone cylinder.

References:

1. Titu Andreescu, & Dorin Andrica (2014). Complex Numbers from A to...Z. (2nd edition). Birkhäuser.
2. Robert J. T. Bell (1994). An Elementary Treatise on Coordinate Geometry of Three Dimensions. Macmillan India Ltd.
3. D. Chatterjee (2009). Analytical Geometry: Two and Three Dimensions. Narosa Publishing House.
4. Leonard Eugene Dickson (2009). First Course in the Theory of Equations. The Project Gutenberg EBook (`http://www.gutenberg.org/ebooks/29785`)
5. Bernard Kolman & David R. Hill (2003). Introductory Linear Algebra with Applications (7th edition). Pearson Education Pvt. Ltd. India.
6. David C. Lay, Steven R. Lay & Judi J. McDonald (2016). Linear Algebra and its Applications (5th edition). Pearson Education Pvt. Ltd. India.
7. David M. Burton (2007). Elementary Number Theory (7th edition). McGraw-Hill.

Course Outcomes: The course will enable the students to:

1. Solve the polynomial equations and to apply De Moivre's theorems.
2. Distinguish between relation, function and tell about concepts of number theory.
3. Solve problems related with matrices, and solve system of linear equations.
4. Solve geometrical calculation regarding planes, straight lines, and spheres.
5. Identify conics with their geometrical shapes.

Course outcomes and their mapping with programme outcomes:

CO	PO												PSO		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	1	2	2				2	1	1	2	1		3
CO2	3	3	1	2	2				3	1	1	2	2		3
CO3	3	3	1	1	1				2	2	1	2	1		3
CO4	3	3	1	1	2				3	1	1	2	1		3
CO5	3	3	1	1	1				3	1	1	2	1		3

Weightage: 1-Slightly, 2-Moderately, 3-Strongly

Sem	Code	Subject	Periods			Evaluation Scheme				Credit
			L	T	P	Internal Assessment		ESE	Subtotal	
						CT-1	CT-2			
B.Sc. II		Elementary Analysis (Major-2)	3	1	-	15	15	70	100	4

Elementary Analysis

Course Objectives: This course will enable the students-

1. Understand about the real number system, open and closed set.
2. Check the convergence of sequence of real numbers.
3. To discuss the convergence of infinite series of real numbers.
4. Understand the sequential approach of limit, continuity, differentiability, uniform continuity.
5. Understand the concepts of mean value theorems, Taylor's forms, higher order derivative of functions, obtain maximum and minimum value of single variable function, and indeterminate forms.

Unit-I: Real Number System

Algebraic and order properties of $\mathbb{R}$, Absolute value of a real number, Bounded above and bounded below sets, Supremum and infimum of a nonempty subset of $\mathbb{R}$, completeness property of $\mathbb{R}$, Archimedean property, Neighbourhood of a point and its properties, Limit point, open and closed sets, interior point, exterior point, boundary point, isolated point, theorems concerning families of open and closed sets, Closure of a set, Cantor nested interval theorem, Countability of sets. Equivalent sets, finite and infinite sets, countable and uncountable sets.

Unit-II: Sequence and Series of Real Numbers

Convergent sequence, Limit of a sequence, Bounded sequence, Limit theorems, Monotone sequences, Monotone convergence theorem, Subsequences, Bolzano-Weierstrass theorem for sequences, Limit superior and limit inferior of a sequence of real numbers, Cauchy sequence, Cauchy's convergence criterion, Convergence and divergence of infinite series of positive real numbers, Necessary condition for convergence, Cauchy criterion for convergence, Tests for convergence of positive term series, Basic comparison test, D'Alembert's ratio test, Cauchy's nth root test, Raabe's Test, Logarithmic test, De Morgan's and Bertrand's test.

Unit-III: Limit, Continuity and Differentiability

Limit of a function (sequential approach), Cauchy criterion for limits at point, Continuity at a point and relevant theorems, Functions continuous on closed intervals, Uniform continuity, Increasing and decreasing functions, Derivability of a function, Necessary condition for the existence of finite derivative, Meaning of the sign of derivative at a point.

Unit-IV: Mean Value Theorem, Indeterminate Forms, Maxima and Minima

Rolle's theorem, Geometrical interpretation of Rolle's theorem, Lagrange's mean value theorem, Cauchy mean value theorem, Geometrical interpretation of mean value theorems, Higher order derivatives, Lebnitz's theorem, Maclaurin's and Taylor's theorems for expansion of a function in infinite series, Taylor's theorem in finite forms with Lagrange, Cauchy and Roache-Schlomich forms of remainder, Maxima and minima, Indeterminate Forms.

References:

1. Shanti Narayana, M. D. Raisinghania, Elements of Real Analysis, S. Chand & Company Ltd.
2. S. C. Malik, Savita Arora, Mathematical Analysis, New Age International(P) Limited, London.
3. Robert G. Bartle & Donald R. Sherbert (2015). Introduction to Real Analysis (4th edition). Wiley India.
4. Gerald G. Bilodeau, Paul R. Thie & G. E. Keough (2015). An Introduction to Analysis (2nd edition), Jones and Bartlett India Pvt. Ltd.
5. K. A. Ross (2013). Elementary Analysis: The Theory of Calculus (2nd edition). Springer.

Course Outcomes: The course will enable the students to:

1. Explain limit point, open and closed sets, interior point, exterior point, boundary point, isolated point, etc.
2. Explain convergent sequence, Limit superior and limit inferior of a sequence of real numbers.
3. Explain convergence and divergence of infinite series with tests.
4. Explain sequential approach of limit and continuity.
5. Explain mean value theorems, Taylor's forms, higher order derivative of functions, obtain maximum and minimum value of single variable function, and indeterminate forms.

Course outcomes and their mapping with programme outcomes:

CO	PO												PSO		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	1			1	2		3	3	1		3	3	1
CO2	3	3	1			2	2		3	3	1		3	3	1
CO3	3	3	1			2	2		3	3	1		3	3	1
CO4	3	3	1			2	2		3	3	1		3	3	1
CO5	3	3	1			2	2		3	3	1		3	3	1

Weightage: 1-Slightly, 2-Moderately, 3-Strongly

Proposed courses to be offered through SWAYAM by the Department of Mathematics, Guru Ghasidas Vishwavidyalaya, Bilaspur, Chhattisgarh

B.Sc. 4th Sem: AEC Paper, Credit – 2

1. Calculus for Economics, Commerce and Management
Course offered by Prof. I. K. Rana, IIT Bombay
SWAYAM Link: https://onlinecourses.nptel.ac.in/noc24_ma56/preview
Course duration: 08 weeks

Course layout:
Week 1 : Revision of basic concepts from Mathematical finance
Week 2 : Basic set theory and concept of functions
Week 3 : Limits and Continuity of a function of one variable and its applications
Week 4 : Derivative and tools to compute
Week 5 : Application of derivatives in increasing/decreasing
Week 6 : Application of derivatives in optimization
Week 7 : Functions of several variables
Week 8 : Applications

2. Calculus of One Real Variable
Course offered by Prof. Joydeep Dutta, IIT Kanpur
SWAYAM Link: https://onlinecourses.nptel.ac.in/noc24_ma47/preview
Course duration: 08 weeks

Course layout:
Week 1:
Lecture 1: Introduction to Numbers
Lecture 2: Countability and Uncountability
Lecture 3: Examples of Irrational numbers
Lecture 4: Functions
Lecture 5: Limits of Functions-I

Week 2:
Lecture 6: Limit of Functions-II
Lecture 7: Continuous Functions
Lecture 8: Intermediate Value Theorem
Lecture 9: Maximum Value Theorem
Lecture 10: Supremum & Infimum

Week 3:
Lecture 11: Derivative of a Function
Lecture 12: Rules of Differentiation
Lecture 13: Derivatives maxima & minima
Lecture 14: Rolle's Theorem and Lagrange MVT(Mean-Value Theorem)
Lecture 15: Monotonic Functions and Inverse Function

Week 4:
Lecture 16: Newton's Method for solving Equations
Lecture 17: Optimization Problems
Lecture 18: Integration-I : In the style of Newton and Leibnitz
Lecture 19: Integration-II : In the spirit of Newton and Leibnitz
Lecture 20: Integration-III : Newton and Leibnitz Style

Week 5:
Lecture 21: Indefinite Integrals
Lecture 22: Integration by Parts
Lecture 23: Integration of Rational Functions
Lecture 24: Trapezoidal Rule for evaluating definite integral
Lecture 25: Simpson's Rule for evaluating definite integral

Week 6:
Lecture 26: Applications of Definite Integral-I
Lecture 27: Applications of Definite Integral-II
Lecture 28: Applications of Definite Integral-III
Lecture 29: Applications of Definite Integral-IV
Lecture 30: Transcendental Functions-I

Week 7:
Lecture 31: Transcendental Functions-II
Lecture 32: Taylor's Expansion-I
Lecture 33: Taylor's Expansion-II
Lecture 34: Infinite Sequence-I
Lecture 35: Infinite Sequence-II

Week 8:
Lecture 36: Infinite series and their convergence
Lecture 37: Tests for Convergence of a series
Lecture 38: Absolute and conditional convergence
Lecture 39: Power Series
Lecture 40: Historical Development of the Calculus

Calculus for Economics, Commerce and Management

By Prof. I. K. Rana | IIT Bombay

Join (/update_profile_and_register?user_email=&raw_slug=/noc24_ma56) **Learners enrolled: 379 | Exam registration: 8**

ABOUT THE COURSE:

This course is based on the course "mathematics for Economics, Commerce and Management", which was run at IIT Bombay for 8 years. Mathematical tools give a precise way of formulating and analyzing a problem and to make logical conclusions. Knowledge of mathematical concepts and tools have have become necessary for students aspiring for higher studies and career in any branch of Economics, Commerce and Management. Math for ECM aims to strengthen the mathematical foundations of students of Economics, Commerce, and Management. Professionals working in these field, wishing to upgrade their knowledge, will also benefit. The stress of the course will be on building the concepts and their applications. The main topic will be Calculus and its applications.

INTENDED AUDIENCE : Students, PhD scholars, teachers, industry **PREREQUISITES** : Basic School Mathematics

Summary

Course Status :	Upcoming
Course Type :	Core
Duration :	8 weeks
Category :	◦ Mathematics
Credit Points :	2
Level :	Undergraduate
Start Date :	22 Jul 2024
End Date :	13 Sep 2024
Enrollment Ends :	29 Jul 2024

Course layout

Week 1 : Revision of basic concepts from Mathematical finance
Week 2 : Basic set theory and concept of functions
Week 3 : Limits and Continuity of a function of one variable and its applications
Week 4 : Derivative and tools to compute
Week 5 : Application of derivatives in increasing/decreasing
Week 6 : Application of derivatives in optimization
Week 7 : Functions of several variables
Week 8 : Applications

Books and references

1. Chiang, A.C. (2005): Fundamental Methods of Mathematical Economics, McGraw Hill, ND.,

Instructor bio

Prof. I. K. Rana

IIT Bombay

Prof. Inder K. Rana presently is an Emeritus Fellow at Department of mathematics, IIT Bombay. He has an experience of 36 years of teaching mathematics courses to undergraduate (B. Tech) and master's M.Sc. students at IIT Bombay. He has authored 4 books,namely,"Introduction to measure and Integration" American Mathematical Society, Graduate Studies in Mathematics Volume 45, 2000,"From Numbers to Analysis" World Scientific Press, 1998 ,Calculus @IITB: Concepts and Examples, math4all, India, 2007 "From Geometry to Algebra: A course in Linear Algebra" math4all, India, 2007.He has won three awards,"C. L. Chandna Mathematics Award" for the year 2000 in recognition of distinguished and outstanding contributions to mathematics research and teaching. The award is given by 'SaraswatiVishvas Canada","Excellence in Teaching" award for the year 2004 Awarded by IIT Bombay, based on the evaluations by students."Aryabhata Award" 2012 All India Ramanujan Math Club, India, for teaching and work towards math education in India.

Course certificate

The course is free to enroll and learn from. But if you want a certificate, you have to register and write the proctored exam conducted by us in person at any of the designated exam centres.
The exam is optional for a fee of Rs 1000/- (Rupees one thousand only).
Date and Time of Exams: **22 September 2024** Morning session 9am to 12 noon; Afternoon Session 2pm to 5pm.
Registration url: Announcements will be made when the registration form is open for registrations.
The online registration form has to be filled and the certification exam fee needs to be paid. More details will be made available when the exam registration form is published. If there are any changes, it will be mentioned then.

Please check the form for more detai ere the exams will be held, the conditions you agree to when you fill the form etc.

(https://swayam.gov.in/) (https://swayam.gov.in/nc_details/NPTEL)

CRITERIA TO GET A CERTIFICATE

Average assignment score = 25% of average of best 6 assignments out of the total 8 assignments given in the course.
Exam score = 75% of the proctored certification exam score out of 100

Final score = Average assignment score + Exam score

YOU WILL BE ELIGIBLE FOR A CERTIFICATE ONLY IF AVERAGE ASSIGNMENT SCORE >=10/25 AND EXAM SCORE >= 30/75. If one of the 2 criteria is not met, you will not get the certificate even if the Final score >= 40/100.

Certificate will have your name, photograph and the score in the final exam with the breakup.It will have the logos of NPTEL and IIT Bombay .It will be e-verifiable at nptel.ac.in/noc (http://nptel.ac.in/noc).

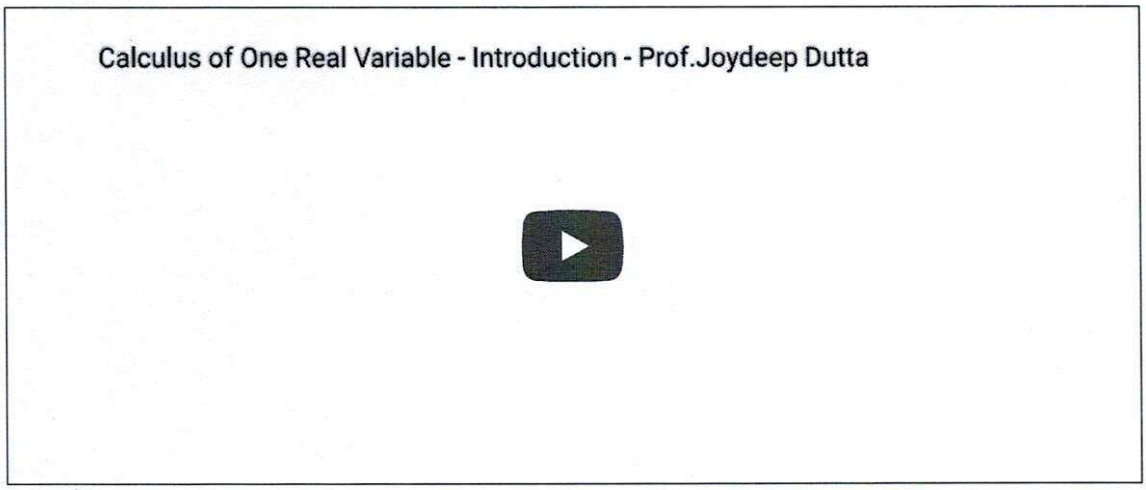
Only the e-certificate will be made available. Hard copies will not be dispatched.

Once again, thanks for your interest in our online courses and certification. Happy learning.

- NPTEL team

Calculus of One Real Variable

By Prof. Joydeep Dutta | IIT Kanpur



ABOUT THE COURSE:

This course intend to develop a thorough understanding of the fundamental aspects of calculus of single variable which is fundamental tool in Sciences, Engineering and Economics.

Intended Audience : First year engineering, science and economics students with mathematics as main course.

Prerequisites : Basic mathematics till 12th standard

Summary

Course Status :	Upcoming
Course Type :	Core

Duration :	8 weeks (https://swayam.gov.in/nc_details/NPTEL)
Category :	Mathematics
Credit Points :	2
Level :	Undergraduate
Start Date :	22 Jul 2024
End Date :	13 Sep 2024
Enrollment Ends :	29 Jul 2024
Exam Registration Ends :	16 Aug 2024
Exam Date :	21 Sep 2024 IST

Note: This exam date is subjected to change based on seat availability. You can check final exam date on your hall ticket.

Course layout

Week 1: Lecture 1: Introduction to Numbers
Lecture 2: Countability and Uncountability
Lecture 3: Examples of Irrational numbers
Lecture 4: Functions
Lecture 5: Limits of Functions-I

Week 2: Lecture 6: Limit of Functions-II
Lecture 7: Continuous Functions
Lecture 8: Intermediate Value Theorem
Lecture 9: Maximum Value Theorem
Lecture 10: Supremum & Infimum

Week 3: Lecture 11: Derivative of a Function
Lecture 12: Rules of Differentiation
Lecture 13: Derivatives maxima & minima
Lecture 14: Rolle's Theorem and Lagrange MVT(Mean-Value Theorem)
Lecture 15: Monotonic Functions and Inverse Function

Week 4: Lecture 16: Newton's Method for solving Equations
Lecture 17: Optimization Problems
Lecture 18: Integration-I : In the style of Newton and Leibnitz
Lecture 19: Integration-II : In the spirit of Newton and Leibnitz
Lecture 20: Integration-III : Newton and Leibnitz Style

Week 5: Lecture 21: Ind
Lecture 22: Integration by Parts
Lecture 23: Integration of Rational Functions
Lecture 24: Trapezoidal Rule for evaluating definite integral
Lecture 25: Simpson's Rule for evaluating definite integral

Week 6: Lecture 26: Applications of Definite Integral-I
Lecture 27: Applications of Definite Integral-II
Lecture 28: Applications of Definite Integral-III
Lecture 29: Applications of Definite Integral-IV
Lecture 30: Transcendental Functions-I

Week 7: Lecture 31: Transcendental Functions-II
Lecture 32: Taylor's Expansion-I
Lecture 33: Taylor's Expansion-II
Lecture 34: Infinite Sequence-I
Lecture 35: Infinite Sequence-II

Week 8: Lecture 36: Infinite series and their convergence
Lecture 37: Tests for Convergence of a series
Lecture 38: Absolute and conditional convergence
Lecture 39: Power Series
Lecture 40: Historical Development of the Calculus

Books and references

1. Calculus by M Spivak
2. Calculus by Thomos and Finney.

Instructor bio

Prof. Joydeep Dutta

IIT Kanpur

Prof.Joydeep Dutta is currently a Professor of Economics at the Department of Humanities and Social Sciences, IIT Kanpur. He was previously a Professor at the Department of Mathematics and Statistics at IIT Kanpur. His reseach interest primarily lies in optimization though he loves mathematics as a whole.

Course certific (https://swayam.gov.in/) (https://swayam.gov.in/nc_details/NPTEL)

The course is free to enroll and learn from. But if you want a certificate, you have to register and write the proctored exam conducted by us in person at any of the designated exam centres.
The exam is optional for a fee of Rs 1000/- (Rupees one thousand only).
Date and Time of Exams: **21 September 2024** Morning session 9am to 12 noon; Afternoon Session 2pm to 5pm.
Registration url: Announcements will be made when the registration form is open for registrations.
The online registration form has to be filled and the certification exam fee needs to be paid. More details will be made available when the exam registration form is published. If there are any changes, it will be mentioned then.
Please check the form for more details on the cities where the exams will be held, the conditions you agree to when you fill the form etc.

CRITERIA TO GET A CERTIFICATE

Average assignment score = 25% of average of best 6 assignments out of the total 8 assignments given in the course.
Exam score = 75% of the proctored certification exam score out of 100

Final score = Average assignment score + Exam score

YOU WILL BE ELIGIBLE FOR A CERTIFICATE ONLY IF AVERAGE ASSIGNMENT SCORE >=10/25 AND EXAM SCORE >= 30/75. If one of the 2 criteria is not met, you will not get the certificate even if the Final score >= 40/100.

Certificate will have your name, photograph and the score in the final exam with the breakup.It will have the logos of NPTEL and IIT Kanpur .It will be e-verifiable at nptel.ac.in/noc (http://nptel.ac.in/noc).

Only the e-certificate will be made available. Hard copies will not be dispatched.

Once again, thanks for your interest in our online courses and certification. Happy learning.

- NPTEL team

Sem	Code	Subject	Periods			Evaluation Scheme				Credit
			L	T	P	Internal Assessment		ESE	Subtotal	
						CT-1	CT-2			
B.Sc. III		Ordinary Differential Equations (Major-3)	3	1	-	15	15	70	100	4

Ordinary Differential Equations

Course Objectives: This course will enable the students-

1. Order and degree of the ordinary differential equations.
2. Existence and uniqueness of the differential equations.
3. The dependence and independence of the solution.
4. Series solution of the differential equations.
5. The practical application of differential equation.

Unit-I: First Order Differential Equations
Order and degree of a differential equation, Differential equations of first order and first degree, Equations in which variables are separable, Homogeneous equations, Linear differential equations and equations reducible to linear form, Exact differential equations, Integrating factor, First order higher degree equations solvable for x, y and p. Clairaut's form and singular solutions. Picard's method of successive approximations and the statement of Picard's theorem for the existence and uniqueness of the solutions of the first order differential equations, Orthogonal trajectories.

Unit-II: Second Order Linear Differential Equations
Statement of existence and uniqueness theorem for linear differential equations, General theory of linear differential equations of second order with variable coefficients, Solutions of homogeneous linear ordinary differential equations of second order with constant coefficients, Transformations of the equation by changing the dependent/independent variable, Method of variation of parameters and method of undetermined coefficients, Reduction of order, Coupled linear differential equations with constant coefficients.

Unit-III: Higher Order Linear Differential Equations Principle of superposition for a homogeneous linear differential equation, Linearly dependent and linearly independent solutions on an interval, Wronskian and its properties, Concept of a general solution of a linear differential equation, Linear homogeneous and non-homogeneous equations of higher order with constant coefficients, Euler-Cauchy equation, Method of variation of parameters and method of undetermined coefficients, Inverse operator method, sturm Liouville problems

Unit-IV: Series Solutions
Power series method, Legendre's equation, Legendre polynomials, Rodrigue's formula, Orthogonality of Legendre polynomials, Orthogonal trajectories.

References:

1. Erwin Kreyszig (2011). Advanced Engineering Mathematics (10th edition). Wiley.
2. B. Rai, D. P. Choudhury & H. I. Freedman (2013). A Course in Ordinary Differential Equations (2nd edition). Narosa.

3. Belinda Barnes & Glenn Robert Fulford (2015). Mathematical Modelling with Case Studies: A Differential Equation Approach Using Maple and MATLAB (2nd edition). Chapman & Hall/CRC Press, Taylor & Francis.

4. H. I. Freedman (1980). Deterministic Mathematical Models in Population Ecology. Marcel Dekker Inc.

5. Daniel A. Murray (2003). Introductory Course in Differential Equations, Orient.

6. Shepley L. Ross (2007). Differential Equations (3rd edition). Wiley India.

7. George F. Simmons (2017). Differential Equations with Applications and Historical Notes (3rd edition). CRC Press, Taylor & Francis.

Course Outcomes: The course will enable the students to:

1. Understand the genesis of ordinary differential equations.
2. Learn various techniques of getting exact solutions of solvable first order differential equations and linear differential equations of higher order.
3. Know Picard's method of obtaining successive approximations of solution of first order differential equations, passing through a given point in the plane and Power series method for higher order linear equations, especially in cases when there is no method available to solve such equations.
4. Grasp the concept of a general solution of a linear differential equation of an arbitrary order and also learn a few methods to obtain the general solution of such equations.
5. Formulate mathematical models in the form of ordinary differential equations to suggest possible solutions of the day-to-day problems arising in physical, chemical, and biological disciplines.

Course outcomes and their mapping with programme outcomes:

CO	PO												PSO		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	2	1								2	2	1	2
CO2	3	3	2	1								2	2	1	2
CO3	3	3	2	1								2	2	1	2
CO4	3	3	2	1								2	2	1	2
CO5	3	3	2	1								2	2	1	2

Weightage: 1-Slightly, 2-Moderately, 3-Strongly

Sem	Code	Subject	Periods			Evaluation Scheme				Credit
			L	T	P	Internal Assessment		ESE	Total	
						CT-1	CT-2			
B.Sc. III		Abstract Algebra (Major-4)	3	1	-	15	15	70	100	4

Abstract Algebra

Course Objectives: This course will enable the students-

1. Understand and analyze group structures.
2. Explore advanced group theories.
3. Study ring theory and its applications.
4. Connect algebraic concepts to number theory.
5. Develop problem-solving and proof-writing skills.

Unit-I: Group, Subgroups and Cyclic Groups
Groups and Subgroups, Finite and Infinite Groups. Elementary properties of groups. Order of a finite group, Dihedral Groups, Quaternion Group, Permutation Groups. Order of an Element, Cyclic Groups with Properties, Euler phi function, Cosets and Lagrange's theorem, Index of subgroups, Euler's theorem, Fermat's little theorem.

Unit-II: Normal Subgroups, Homomorphism and Isomorphisms
Normal Subgroups, Quotient Groups, Simple Group, Cauchy's theorem for finite abelian groups; Centralizer, Normalizer, Center of a group, Product of two subgroups. Direct product and direct sum, Group Homomorphisms and Isomorphisms, First, Second and Third isomorphism theorems for groups.

Unit III: Permutation Group and Finitely generated abelian groups
Cycle notation for Permutations, Properties of Permutations, Even and Odd Permutations, Symmetric Group S_n, Cayley's Theorem, Finitely generated abelian groups, Cauchy's theorem on abelian group, Cauchy's theorem.

Unit IV: Ring, Integral Domain and Field
Rings with examples and properties, Subring, Characteristic of a ring, Ideal, Ideal generated by a subset of a ring, operations on ideals, Factor rings, Prime ideals, Maximal and Minimal ideals, Ring Homomorphism, Isomorphism theorems, Polynomial Ring, Integral Domain, Principal Ideal Domain, Factorization of polynomials, Fields, Subfields.

References:

1. Joseph A. Gallian (2017). Contemporary Abstract Algebra (9th edition). Cengage.
2. Devid S. Dummit and Richard M. Foote, Abstract Algebra, John Wiley & Sons, Inc.
3. Michael Artin (2014). Algebra (2nd edition). Pearson.
4. John B. Fraleigh (2007). A First Course in Abstract Algebra (7th edition). Pearson.

5. Joseph A. Gallian (2017). Contemporary Abstract Algebra (9th edition). Cengage.
6. I. N. Herstein (2006). Topics in Algebra (2nd edition). Wiley India.
7. Nathan Jacobson (2009). Basic Algebra I (2nd edition). Dover Publications.
8. Ramji Lal (2017). Algebra 1: Groups, Rings, Fields and Arithmetic. Springer.
9. I.S. Luthar & I.B.S. Passi (2013). Algebra: Volume 1: Group, Narosa.

Course Outcomes: Students will be able to understand after the completion of the course:

1. The fundamental concepts of group theory, including groups, subgroups, and cyclic groups. Analyze the properties and structures of finite and infinite groups, as well as specific groups such as dihedral, quaternion, and permutation groups.
2. Apply group and ring theory concepts to solve problems in number theory, including Euler's phi function, Lagrange's theorem, Euler's theorem, and Fermat's little theorem.
3. Investigate normal subgroups, quotient groups, and the implications of Cauchy's theorem for finite abelian groups. Understand and apply the concepts of group homomorphism, isomorphism, and the isomorphism theorems.
4. Gain a thorough understanding of ring theory, including the definitions and properties of rings, subrings, integral domains, and ideals. Explore the concept of ring homomorphism and apply the isomorphism theorems to ring structures.
5. Analyze the structure of polynomial rings, principal ideal domains, and the factorization of polynomials. Enhance logical reasoning and proof-writing skills through rigorous problem-solving and theorem proving.

Course outcomes and their mapping with programme outcomes:

CO	PO												PSO		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	2	1	1	1	2	2	1	2	3	2		2	1	2
CO2	2	2	1	1	1	2	2	1	2	3	2		2	1	2
CO3	2	2	1	1	1	2	2	2	2	3	2		2	1	2
CO4	1	2	1	1	1	2	2	3	2	3	2		2	1	2
CO5	2	2	1	1	1	2	2	3	2	3	2		2	1	2

Weightage: 1-Slightly, 2-Moderately, 3-Strongly

Sem	Code	Subject	Periods			Evaluation Scheme				Credit
			L	T	P	Internal Assessment		ESE	Total	
						CT-1	CT-2			
B.Sc. IV		Advanced Analysis (Major-5)	4	1	-	15	15	70	100	5

Advanced Analysis

Course Objectives: This course will enable the students-

1. To understand partition, Darboux sum and Riemann integration.
2. To understand the concepts of improper integration, necessary and sufficient conditions for convergence of improper integrals.
3. To understand the convergence of sequences of functions.
4. To understand the importance of the Fourier series and its application in real-life problems.
5. To study the theory of power series and its convergence.

Unit-I: Riemann Integration

Inequalities of upper and lower sums, Darboux integration, Darboux theorem, Riemann conditions of integrability, Riemann sum and definition of Riemann integral through Riemann sums, equivalence of two definitions. Riemann integrability of monotone and continuous functions, properties of the Riemann integral; Integrability of functions with infinitely many discontinuities having finitely many limit points, Definition and integrability of piecewise continuous and monotone functions. Fundamental theorem of Integral Calculus, Mean value theorems of integral calculus.

Unit-II: Improper Integrals

Convergence of improper integrals of the first kind, Test for convergence at 'a', Necessary and sufficient condition for the convergence of improper integral. comparison of two integrals, practical comparison test, absolute convergence, Abel's and Dirichet test, Convergence of Beta and Gamma functions. Problems on Beta and Gamma functions.

Unit-III: Uniform Convergence and Series of Functions

Pointwise and uniform convergence of sequence of functions, Theorems on continuity. differentiability and integrability of the limit function of a sequence of functions, Theorems on the continuity and differentiability of the sum function of a series of functions; Cauchy criterion for uniform convergence and Weierstrass M-Test, Weierstrass approximation theorem.

Unit-IV: Power Series

Radius of convergence, Cauchy-Hadamard theorem. Differentiation and integration of power series, Abel's theorem, Dirichlet's Theorem.

Unit-V: Fourier Series

Definition of Fourier coefficients and series, Riemann-Lebesgue lemma, Bessel's inequality, Parseval's identity, Dirichlet's condition. Examples of Fourier expansions and summation

results for series.

References:

1. R.G. Bartle and D.R. Sherbert, Introduction to Real Analysis, 3rd Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2002.
2. T.M. Apostol, Mathematical Analysis, Narosa, 1996.
3. C.G. Denlinger, Elements of Real Analysis, Jones & Bartlett (Student Edition), 2011.
4. S.C. Malik and Savita Arora, Mathematical Analysis, New Age International Limited, New Delhi.

Course Outcomes: Students will be able to learn the following in this course:

1. Conditions for Riemann integrability and related properties.
2. Convergence of improper integrals.
3. Conditions for convergence of series and sequences of functions.
4. Finding Fourier series expansion of functions.
5. Convergence of power series.

Course Outcomes and their mapping with programme outcomes:

CO	PO												PSO		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	1	1	2	2						2	3	3	2	1
CO2	2	3	3	3	3						3	3	1	1	3
CO3	2	2	4	2	3						2	3	3	2	1
CO4	2	3	2	3	3						2	2	2	3	2
CO5	2	3	3	3	3						2	3	3	2	1

Weightage: 1-Slightly, 2-Moderately, 3-Strongly

Sem	Code	Subject	Periods			Evaluation Scheme				Credit
			L	T	P	Internal Assessment		ESE	Total	
						CT-1	CT-2			
B.Sc. IV		Multivariable and Vector Calculus (Major-6)	3	1	-	15	15	70	100	4

Multivariable and Vector Calculus

Course Objectives: This course will enable the students-

1. To learn conceptual variations while advancing from one variable to several variables in calculus.
2. To understand the concepts of higher order partial differential equations.
3. To understand the concepts of finding maxima and minima of the functions of two and more variables.
4. To understand the concepts of double and triple integration with their geometrical meaning, finding asymptotes, radius of curvature and envelope of family of curves.
5. To understand Green's, Stokes' and Gauss Divergence Theorem and line, surface and volume integrals.

Unit-I: Functions of Several Variables
Functions of several variables, limit and continuity of functions of two or more variables. Partial differentiation, total differentiability and differentiability, sufficient condition for differentiability. Chain rule for one and two independent parameters, directional derivatives, the gradient, maximal and normal property of the gradient, tangent planes, Extrema of functions of two variables, method of Lagrange multipliers, constrained optimization problems.

Unit-II: Differentiation and Integration of Vector Functions
Triple product, introduction to vector functions, operations with vector-valued functions, limits and continuity of vector functions, differentiation and integration of vector functions. Definition of vector field, divergence and curl. Line integrals, applications of line integrals: mass and work. Fundamental theorem for line integrals, conservative vector fields, independence of path, Green's, Stoke's and Divergence Theorem with applications.

Unit-III: Double and Triple Integrals
Double integration over rectangular region, double integration over non-rectangular region, Double integrals in polar coordinates, Triple integrals, triple integral over a parallelepiped and solid regions. Volume by triple integrals, cylindrical and spherical coordinates. Change of variables in double integrals and triple integrals.

Unit-IV: Curvature, Asymptotes and Curve Tracing for one variable
Curvature, Parametric equations, arc length, arc length of parametric curves, Asymptote, Radius of curvature, Concavity and convexity, inflection points, envelopes, Tracing of Cartesian, polar and Parametric curves.

References:

1. G.B. Thomas and R.L. Finney, *Calculus*, 9th Ed., Pearson, 2005.
2. T.M. Apostol, *Mathematical Analysis*, Narosa, 1996.
3. Jerrold Marsden, Anthony J. Tromba & Alan Weinstein (2009). *Basic Multivariable Calculus*, Springer India Pvt. Limited.
4. James Stewart (2012). *Multivariable Calculus* (7th edition). Brooks/Cole. Cengage.
5. Monty J. Strauss, Gerald L. Bradley & Karl J. Smith (2011). *Calculus* (3rd edition). Pearson Education. Dorling Kindersley (India) Pvt. Ltd.
6. George B. Thomas Jr., Joel Hass, Christopher Heil & Maurice D. Weir (2018). *Thomas' Calculus* (14th edition). Pearson Education.
7. Jerrold Marsden & Alan Weinstein (1985). *Calculus III*, Springer-Verlag.

Course Outcomes: This course will enable the students to learn the following:

1. Partial derivatives of a function of more than one variable.
2. Finding extrema of functions of two variables.
3. Differentiation and integration of vector-valued functions.
4. Computation of multiple integrals and finding asymptotes, envelope and radius of curvature.
5. Application of Green's, Stokes' and divergence theorems.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	1	1	1	2						3	3	1	2	1
CO2	2	3	3	3	3						1	3	3	3	2
CO3	2	2	2	1	3						2	3	2	2	1
CO4	3	3	2	3	3						3	2	3	3	3
CO5	2	3	3	2	3						2	3	3	2	1

Weightage: 1-Slightly, 2-Moderately, 3-Strongly

Sem	Code	Subject	Periods			Evaluation Scheme				Credit
			L	T	P	Internal Assessment		ESE	Total	
						CT-1	CT-2			
B.Sc. IV		Linear Programming and Game Theory (Major-7)	4	1	-	15	15	70	100	5

Linear Programming and Game Theory

Course Objectives: This course will enable the students to-

1. understand basic terminology and basic concepts related to linear programming problems (LPP) of real-life situations.
2. Understand the few initial methods for the solutions of linear programming problems.
3. Understand the duality concept of linear programming problems.
4. Know about sensitivity analysis of linear programming problems.
5. Learn about the applications of LPP for solving transportation, assignment, and two-person zero-sum game problems.

Unit-I: Linear Programming Problem, Convexity and Basic Feasible Solutions
Formulation, Canonical and standard forms, Graphical method; Convex and polyhedral sets, Hyperplanes, Extreme points; Basic solutions, Basic Feasible Solutions, Reduction of feasible solution to basic feasible solution, Correspondence between basic feasible solutions and extreme points.

Unit-II: Simplex Method
Optimality criterion, improving a basic feasible solution, Unboundedness, Unique and alternate optimal solutions; Simplex algorithm and its tableau format; Artificial variables, Two-phase method, Big-M method.

Unit-III: Duality
Formulation of the dual problem, Duality theorems, Complimentary slackness theorem, Economic interpretation of the dual, Dual-simplex method.

Unit-IV: Sensitivity Analysis
Changes in the cost vector, right-hand side vector and the constraint matrix of the linear programming problem.

Unit-V: Applications
Transportation Problem: Definition and formulation, Methods of finding initial basic feasible solutions: Northwest-corner rule, Least-cost method, Vogel approximation method; Algorithm for obtaining optimal solution. Assignment Problem: Mathematical formulation and Hungarian method. Game Theory: Formulation and solution of two-person zero-sum games, Games with mixed strategies, Linear programming method for solving a game.

References:

1. Mokhtar S. Bazaraa, John J. Jarvis & Hanif D. Sherali (2010). *Linear Programming and Network Flows* (4th edition). John Wiley & Sons.
2. G. Hadley (2002). *Linear Programming.* Narosa Publishing House.
3. Frederick S. Hillier & Gerald J. Lieberman (2015). *Introduction to Operations Research* (10th edition). McGraw-Hill Education.
4. Hamdy A. Taha (2017). *Operations Research: An Introduction* (10th edition). Pearson.
5. Paul R. Thie & Gerard E. Keough (2014). *An Introduction to Linear Programming and Game Theory* (3rd edition). Wiley India Pvt. Ltd.

Course Outcome: Students will learn:

1. Basic understanding & terminology related to linear programming problems (LPP) of real-life situations.
2. Some initial methods for the solutions of linear programming problems.
3. The duality concept of linear programming problems.
4. Awareness about sensitivity analysis of linear programming problems.
5. Applications of LPP for solving transportation, assignment, and two-person zero-sum game problems.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	1	2	2						2	3	2	1	1
CO2	2	3	3	3	3						3	3	3	2	3
CO3	2	3	3	3	3						2	3	1	3	1
CO4	2	3	2	3	3						2	2	3	2	2
CO5	2	3	3	3	3						2	3	3	2	1

Weightage: 1-Slightly, 2-Moderately, 3-Strongly

Sem	Code	Subject	Periods			Evaluation Scheme				Credit
			L	T	P	Internal Assessment		ESE	Total	
						CT-1	CT-2			
B.Sc. IV.		Differential Calculus (Minor-3)	3	1	-	15	15	70	100	4

Differential Calculus

noindent**Course Objectives:** This course will enable the students to-

1. Calculate the limit and examine the continuity and uniform continuity of a function.
2. Obtain derivatives of a real-valued function and explore the geometrical interpretation of differentiability and the mean value theorems.
3. Express the function in series form.
4. Understand the concepts of partial differentiation.
5. Determine the maxima and minima of functions of single and several variables.

Unit I: Limit and Continuity
Definition of limit of a real-valued function, Limit at infinity and infinite limits, Continuity of a real-valued function, Properties of continuous functions, Intermediate value theorem, Geometrical interpretation of continuity, Types of discontinuity, Uniform continuity.

Unit II: Differentiability
Differentiability of a real-valued function, Geometrical interpretation of differentiability, Relation between differentiability and continuity, Differentiability and Monotonicity, Chain rule of differentiation, Darboux's theorem, Rolle's theorem, Lagrange's mean value theorem, Cauchy mean value theorem, Geometrical interpretation of mean value theorem, Successive differentiation, Leibnitz's theorem.

Unit III: Expansion of the Functions
Sequence, Series, infinite series, higher derivatives, Leibnitz's theorem, Maclaurin's and Taylor's theorem for expansion of the function in an infinite series. Maxima and Minima for single variable functions, Indeterminate Forms.

Unit IV: Partial Differentiation
Functions of two or more variables, Partial derivative, homogeneous functions, Euler's theorem, Total derivative, Change of variable, Jacobians, Maxima and minima of function of two variables, Lagrange's method of undetermined multipliers.

References:

1. Shanti Narayana, M. D. Raisinghania, *Elements of Real Analysis*, S. Chand & Company Ltd.
2. Gorakh Prasad, *Differential Calculus*, Pothishala Pvt. Ltd.
3. Howard Anton, I. Bivens, S. Stephan Davis, *Calculus*, Wiley India.

4. B. S. Grewal, *Higher Engineering Mathematics*, Khanna Publisher.
5. H. K. Das, *Higher Engineering Mathematics*, S. Chand Publishing.
6. Gabriel Klambauer, *Aspects of Calculus*, Springer-Verlag.
7. George B. Thomas Jr., Joel Hass, Christopher Heil & Maurice D. Weir (2018), *Thomas' Calculus* (14th Edition), Pearson Education.

Course Outcomes: Students will be able to understand after the completions of the course:

1. Understand and apply the concepts of limits and continuity.
2. Master the techniques of differentiation for real-valued functions.
3. Learn partial differentiation and its applications.
4. Represent functions as series expansions.
5. Analyze and solve problems involving the maxima and minima of functions.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	2	1	3	1	2	2	1	1	3	2	1	2	1	2
CO2	2	2	1	3	1	2	2	1	1	3	2	1	2	1	2
CO3	2	2	1	3	1	2	2	2	1	3	2	1	2	1	2
CO4	1	2	1	3	1	2	2	3	1	3	2	1	2	1	2
CO5	2	2	1	3	1	2	2	3	1	3	2	1	2	1	2

Weightage: 1-Slightly, 2-Moderately, 3-Strongly

Sem	Code	Subject	Periods			Evaluation Scheme				Credit
			L	T	P	Internal Assessment		ESE	Total	
						CT-1	CT-2			
B.Sc. IV.		Vector Calculus (Minor-4)	3	1	-	15	15	70	100	4

Vector Calculus

Course Objectives: This course will enable the students to-

1. Recognize and sketch surfaces in three-dimensional space.
2. Compute dot products and cross products and interpret their geometric meaning.
3. Compute directional derivatives and gradients of scalar functions and explain their meaning.
4. Recognize and apply the Fundamental Theorem of Line Integrals, Green's Theorem, Divergence Theorem, and Stokes' Theorem correctly.
5. Equip students to analyze vector differentiation and the evaluation of line, surface, and volume integrals and their applications.

Unit I: Basics of Vectors
Three-dimensional coordinate system, vectors, dot product, cross product, equations of lines and planes, space curves, cylinders and quadric surfaces, cylindrical and spherical coordinates.

Unit II: Limits, Continuity and Differentiation of Vector Valued Functions
Vector valued functions, algebraic operations on vector valued functions, limits and continuity of vector valued functions, differentiation and partial differentiation of vector functions, velocity and acceleration.

Unit III: Gradient, Curl and Divergence
Scalar and vector fields, gradient of scalar field, directional derivative, properties of gradient, divergence of vector function, curl of vector function, properties of divergence and curl, conservative vector fields,

Unit IV: Integration on $\mathbb{R}^2$ and $\mathbb{R}^3$
Double and triple integrals, integration of vector functions, line integral, surface integral, and volume integral, Green's Theorem, Gauss Divergence Theorem, Stoke's Theorem with applications.

References:

1. *Vector Analysis*, Schaum's Outlines, Second Edition.
2. *Calculus – Early Transcendentals* by James Stewart (2006 Edition).
3. Dass, H. K. *Higher Engineering Mathematics*. S. Chand Publishing, 2011.

Course Outcomes: This course will enable the students to:

1. Perform vector operations, determine equations of lines and planes, and parametrize 2D & 3D curves.
2. Understand and apply the concepts of vector functions and the differentiation of vector functions to find the velocity and acceleration.
3. Understand and apply the concepts of vector fields, scalar fields, gradient, divergence, and curl.
4. Evaluate double integrals in Cartesian and polar coordinates; evaluate triple integrals in rectangular, cylindrical, and spherical coordinates; and calculate areas and volumes using multiple integrals.
5. Apply Green's Theorem, Stokes' Theorem, and Gauss' Theorem in solving various problems.

Course Outcomes and their Mapping with Programme Outcomes:

CO	PO												PSO		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	3	2	1	2	2	2	2	3	3	3	2	2	1	2
CO2	2	3	2	1	2	3	2	2	3	3	3	2	2	1	2
CO3	2	3	2	1	2	3	2	2	3	3	3	2	2	1	2
CO4	2	3	2	1	2	3	2	2	3	3	3	2	2	1	2
CO5	2	3	2	1	2	3	2	2	3	3	3	2	2	1	2

Weightage: 1-Slightly, 2-Moderately, 3-Strongly

Sem	Code	Subject	Periods			Evaluation Scheme				Credit
			L	T	P	Internal Assessment		ESE	Total	
						CT-1	CT-2			
B.Sc. III		Numerical Method (MDC-3)	2	1	-	15	15	70	100	3

Numerical Methods

Course Objectives: This course will enable the students-

1. To understand error analysis.
2. To solve nonlinear equations.
3. To understand master techniques to solve system of linear equations.
4. To fit models to data.
5. To enhance analytical skills.

Unit-I: Solutions of Transcendental and polynimial equations
Types of errors: Round-off, truncation, absolute, relative Precision and accuracy in computations, rate of convergence: definition and examples Comparison of convergence rates for different methods, Transcendental and polynimial equations, direct methos, Initial approximation, Intermediate value theorem, bisection method, Secant and Regula-Falsi Method, Newton-Raphson method.

Unit-II: Solution of linear simultaneous equations
Solution of linear simultaneous equations, Gauss elimination methods, Gauss-Jordan method, Jacobi iterartive method.

Unit-III: Curve fitting
Method of Least Squares, Derivation and purpose, Applications in data fitting, Fitting Curves, Quadratic polynomial $y = a + bx + cx^2$, Straight line $y = bx + c$, Parabola $y = a + bx + cx^2$, Power curve $y = ax^b$.

Reference Books:

1. Brian Bradie (2006), A Friendly Introduction to Numerical Analysis. Pearson.
2. C. F. Gerald P. O. Wheatley (2008). Applied Numerical Analysis (7th edition), Pearson Education, India.
3. F. B. Hildebrand (2013). Introduction to Numerical Analysis: (2nd edition). Dover Publications.
4. M. K. Jain, S. R. K. Iyengar R. K. Jain (2012). Numerical Methods for Scientific and Engineering Computation (6th edition). New Age International Publishers.
5. Robert J. Schilling Sandra L. Harris (1999). Applied Numerical Methods for Engineers Using MATLAB and C. Thomson-Brooks/Cole.

Course Outcomes: This course will enable the students to:

1. Learn to identify and quantify different types of computational errors to improve the accuracy and reliability of numerical solutions.
2. Develop proficiency in using methods like Bisection, Newton-Raphson, and Secant to find roots of transcendental and polynomial equations.
3. Master techniques such as Gauss elimination, Gauss-Jordan, Jacobi, and Gauss-Seidel to efficiently solve systems of linear equations.
4. Use the method of least squares to fit various curves. including lines and polynomials, to data sets for better predictions and insights.
5. Cultivate problem-solving and analytical skills by understanding the convergence, efficiency, and application of numerical methods in real-world scenarios.

Course Outcomes and their Mapping with Programme Outcomes:

CO	PO												PSO		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	2		1		3			1		2	1	1	1	
CO2	1	2		1		1			2		2	1	1	1	
CO3	1	2		1					2		2	1	2	1	
CO4	1	2		1					2		2	1	2	1	
CO5	1	2		1					2		2	1	2	1	

Weightage: 1-Slightly, 2-Moderately, 3-Strongly

Sem	Code	Subject	Periods			Evaluation Scheme				Credit
			L	T	P	Internal Assessment		ESE	Total	
						CT-1	CT-2			
B.Sc. III.		Vedic Mathematics (AEC-3)	2	0	-	15	15	70	100	2

Vedic Mathematics

Course Objectives: This course will enable the students to-

1. Gain proficiency in Vedic Mathematical computations.
2. Learn three main tools for analyzing and describing the behaviour of Vedic Mathematics.
3. Demonstrate some Sutras.
4. Gain deep knowledge about Vedic Mathematics.
5. Understand the tools to solve application problems using Vedic Mathematics.

Unit-I:
Introduction to Vedic Mathematics, Vedic Mathematics-Sutras and Up sutras, Friend and Fast Friend Digit, Addition, Subtraction, Multiplication, Urdhan Triyaghbyam method, Eknuen Purvena method, Deviation Method(Nikhilam), Duplex, Dwandwa yogah, Square and square root, Cube and Cube roots.

Unit-II:
Deviation Method, Paravartya Method, Dhwanjak Method, Mixed Operation, L.C.M. and H.C.F., Rules of Divisibility, Vinculum Number, Application of Vinculum Number, Digital Roots, Introduction of Several Indian Mathematicians.

References:

1. *Vedic Mathematics: Sixteen Simple Mathematical Formulae from the Vedas*, Jagadguru Swami Sri Bharati Krishna Trithaji, Motilal Banarasidas, New Delhi 2015.
2. *The Essential of Vedic Mathematics*, Rajesh Kumar Thakur, Rupa Publications, New Delhi 2019.
3. *Vedic Mathematics Made Easy*, Dhaval Bathia, Jaico Publishing, New Delhi 2011.
4. *Learn Vedic Speed Mathematics Systematically*, Chaitanya A. Patil 2018.

Course Outcomes: The course will enable the students to:

1. Foster love for mathematics and remove its fear through Vedic Mathematics.
2. Enhance computation skills in students through Vedic Mathematics.
3. Develop logical and analytical thinking.
4. Promote joyful learning of mathematics.
5. Discuss the rich heritage of the mathematical temper of Ancient India.

Course Outcomes and their Mapping with Programme Outcomes:

CO	PO												PSO		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2				2							1		
CO2	3	2				2							1		
CO3	3	2				2							1		
CO4	3	2				2							1		
CO5	3	2				2							1		

Weightage: 1-Slightly, 2-Moderately, 3-Strongly

Sem	Code	Subject	Periods			Evaluation Scheme				Credit
			L	T	P	Internal Assessment		ESE	Total	
						CT-1	CT-2			
B.Sc. IV		Basics of Probability (AEC-4)	2	0	-	15	15	70	100	2

Basics of Probability

Course Objectives: This course will enable the students to-

1. Explain the basic ideas of random experiment, sample space, and probability.
2. Use the basic probability rules, including additive and multiplicative laws.
3. Understand the concepts of random variable and its behavior.
4. Adapt the knowledge of various discrete probability distributions and their applications.
5. Adapt the knowledge of normal distribution and its applications.

Unit I: Permutations, Combinations

Principle of counting, Permutations, Combinations, Random experiment, Sample space, events, types of events, Mathematical and statistical definitions of probability, Theorem of total probability, Compound Probability, Conditional probability, independent events, Theorem of compound probability.

Unit II: Random and Discrete Variables

Random variable, discrete and continuous random variables, Mathematical Expectation, Mean, Variance, Mean deviation, Binomial distribution, Mean and standard deviation of Binomial Distribution, Normal distribution, Properties of Normal distribution, mean and standard deviation of Normal distribution.

References:

1. M. Ray, H. S. Sharma and U. N. Singh, *Statistical Methods*, Ram Prasad Publications (RPH), 1987.
2. S. C. Gupta and V. K. Kapoor, *Fundamentals of Mathematical Statistics*, Sultan Chand & Sons, 2020.
3. Sheldon M. Ross, *Introduction to Probability Models*, Academic Press, 2014.

Course Outcomes: Upon successful completion of this course, students will be able to:

1. Solve basic problems regarding probability.
2. Apply the concept of conditional probability to solve related problems.
3. Analyze data pertaining to discrete and continuous variables and interpret the results.
4. Apply suitable discrete probability distribution models for the given scenario.
5. Understand normal distribution and its implementation in realistic models.

Course Outcomes and their Mapping with Programme Outcomes:

CO	PO												PSO		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	3	2	2	2	2	3	2	2	2	3	3		2	
CO2	1	3	3	2	2	2	3	2	2	2	3	3		2	
CO3	2	3	3	2	2	2	3	2	2	2	3	3		2	
CO4	3	3	3	2	2	2	3	2	2	2	3	3		2	
CO5	3	3	3	2	2	2	3	2	2	2	3	3		2	

Weightage: 1-Slightly, 2-Moderately, 3-Strongly

Sem	Code	Subject	Periods			Evaluation Scheme				Credit
			L	T	P	Internal Assessment		ESE	Total	
						CT-1	CT-2			
B.Sc. III.		Boolean Algebra (SEC-3)	2	1	-	15	15	70	100	3

Boolean Algebra

Course Objectives: This course will enable the students to-

1. Understand Boolean Algebra and Theorems.
2. Explore Boolean Functions and Canonical Forms.
3. Apply Advanced Boolean Concepts.
4. Analyze Logic Gates and Their Applications.
5. Design and Analyze Switching Circuits.

Unit-I:
Truth tables, Properties of Boolean algebra, Principle of Duality, De-Morgan's Theorem. Boolean function, Mid-Term or Minimal Boolean function, Disjunctive normal form or canonical form, Complete disjunctive normal form or canonical form or complete canonical form.

Unit-II:
Boole's expansion Theorem, Complement function of a Boolean function in disjunctive normal form, Mix- term of Maximal Boolean function, Conjunctive normal form or Dual Canonical form, Complete Conjunctive normal form.

Unit-III:
Logic gates, AND gate, OR gate, NOT gate, NAND gate, NOR gate, XOR gate, XNOR gate, Buffer gate, Universal gate, Applications of Logic gates, Switching Circuits, Parallel Circuits, Series Circuits, Relay Circuits, Various Position of Switches and Currents in electric Circuits, Simple Arithmetic and Logic Circuits, Adder, Sub tractor, Simple Combinational Circuit design Problems.

References:

1. J. Eldon Whitesitt, *Boolean Algebra and Its Applications*, Dover Publications, 2010.
2. Abhijit Debnath, *Basic Concept of Boolean Algebra & Switching Circuits*, Sankalp Publications, 2019.
3. Paul R. Halmos, *Lectures on Boolean Algebras*, Martino Fine Books, 2013.

Course Outcomes: The course will enable the students to:

CO1: Master on Boolean Algebra and Theorems.

CO2: Express and Simplify Boolean Functions.

CO3: Apply Advanced Boolean Concepts.

CO4: Design and Implement Logic Gate Circuits.

CO5: Analyze and Design Switching Circuits.

Course Outcomes and their Mapping with Programme Outcomes:

CO	PO												PSO		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	3	2	1	3	3	1		2	3	3	3	2		
CO2	3	2	2	3		2	1		1	1	2	3	2		
CO3	3	3	2	2	3	3	3		3	3	3	3	2		
CO4	3	3	3	3	3	3	3		3	3	3	3	2		
CO5	3	3	3	3	3	3	3		3	3	3	3	2		

Weightage: 1-Slightly, 2-Moderately, 3-Strongly

Proposed courses to be offered through SWAYAM by the Department of Mathematics, Guru Ghasidas Vishwavidyalaya, Bilaspur, Chhattisgarh

B.Sc. 3rd Sem: SEC Paper, Credit – 3

1. Engineering Mathematics – I

Course offered by Prof. Jitendra Kumar, IIT Kharagpur
SWAYAM Link: https://onlinecourses.nptel.ac.in/noc24_ma93/preview
Course duration: 12 weeks

Course layout:

Week 1 : Differential Calculus - Functions of One Variable
Week 2 : Partial Derivatives
Week 3 : Total Differential and Differentiability
Week 4 : Taylor's Expansion of Functions. Maxima and Minima
Week 5 : Improper Integrals
Week 6 : Double Integrals
Week 7 : Multiple Integrals & their Applications
Week 8 : System of Linear Equations - Gauss Elimination. Vector Spaces
Week 9 : Linear Transformations
Week 10 : Eigenvalues and Eigenvectors, Diagonalization
Week 11 : First Order Differential Equations
Week 12 : Higher Order Differential Equations with Constant Coefficientss

2. Advanced Calculus For Engineers

Course offered by Prof. Jitendra Kumar and Prof. Somesh Kumar, IIT Kharagpur
SWAYAM Link: https://onlinecourses.nptel.ac.in/noc24_ma91/preview
Course duration: 12 weeks

Course layout:

Week 1: Differential calculus of one variable
Week 2: Limit, continuity, partial derivatives of functions of two or more variables
Week 3: Differentiability of functions of two or more variables
Week 4: Differentiation of Homogeneous and Implicit Functions, Taylors theorem of functions of two variables
Week 5: Maxima and Minima
Week 6: First order ODEs
Week 7: Higher order ODEs
Week 8: Improper integrals
Week 9: Double integrals
Week 10: Triple Integrals
Week 11: Vector and scalar field, gradient, divergence and curl
Week 12: Line and surface integrals. Green, Stokes and Gauss divergence theorems

Engineering Mathematics - I

By Prof. Jitendra Kumar | IIT Kharagpur

Join (/update_profile_and_register?user_email=&raw_slug=/noc24_ma93) **Learners enrolled: 887 | Exam registration: 11**

ABOUT THE COURSE:

This course is about the basic mathematics that is fundamental and essential component in all streams of undergraduate studies in sciences and engineering. The course consists of topics in differential calculus,integral calculus, linear algebra and differential equations with applications to various engineering problems. This course will cover the following main topics: Mean Value Theorems; Indeterminate Forms; Taylor's and Maclaurin's Theorems. Partial Derivatives; Differentiability; Taylor's Expansion of Functions of Several Variables. Maxima and Minima. Improper Integrals. Differentiation under Integral Sign (Leibnitz rule).Multiple Integrals and their Properties. Applications of Multiple Integrals. System of Linear Equations. Vector Spaces; Basis and Dimension of a Vector Space. Rank of a Matrix and its Properties. Linear Transformation. Eigenvalues and Eigen vectors. Diagonalization . First Order Differential Equations. Higher Order Differential Equations with Constant Coefficients. Cauchy-Euler Equations.

Summary

Course Status :	Upcoming
Course Type :	Core
Duration :	12 weeks
Category :	◦ Mathematics
Credit Points :	3
Level :	Undergraduate
Start Date :	22 Jul 2024
End Date :	11 Oct 2024
Enrollment Ends :	29 Jul 2024
Exam Registration Ends :	16 Aug 2024
Exam Date :	03 Nov 2024 IST

Note: This exam date is subjected to change based on seat availability. You can check final exam date on your hall ticket.

Course layout

Week 1 : Differential Calculus - Functions of One Variable
Week 2 : Partial Derivatives
Week 3 : Total Differential and Differentiability
Week 4 : Taylor's Expansion of Functions. Maxima and Minima
Week 5 : Improper Integrals
Week 6 : Double Integrals
Week 7 : Multiple Integrals & their Applications
Week 8 : System of Linear Equations - Gauss Elimination. Vector Spaces
Week 9 : Linear Transformations
Week 10 : Eigenvalues and Eigenvectors, Diagonalization

Week 11 : First C ...uations
Week 12 : Highe... Equations with Constant Coefficients

Books and references

1. Piskunov, N., Differential and Integral Calculus, Vol 1 & 2, 2nd edition.Mir Publishers, 1974.
2. Kreyszig, E., Advanced Engineering Mathematics, 10th edition. John Wiley & Sons, 2010.
3. Thomas Jr, George B., Weir, Maurice D. and Hass, Joel R., Thomas' Calculus, 12th edition. Pearson 2014.
4. O'Neil, Peter V., Advanced Engineering Mathematics, 7th edition. Cengage learning, 2011.
5. Strang, G., Linear Algebra and its Applications, Fourth Edition, 2009.
6. Thomas, G.B. and Finney, R.L., Calculus and Analytic Geometry, 9th Edition, Pearson, Reprint, 2002.

Instructor bio

Prof. Jitendra Kumar

IIT Kharagpur

Jitendra Kumar is an Associate Professor at the Department of Mathematics, IIT Kharagpur. He completed his M.Sc. in Industrial Mathematics from IIT Roorkee and Technical University of Kaiserslautern, Germany in 2001 and 2003, respectively. He received his PhD degree in 2006 from Otto-von-Guericke University Magdeburg, Germany. He was Research Associate at the Institute for Analysis and Numerical Mathematics, Otto-von-Guericke University Magdeburg, Germany from 2006 to 2009. Dr. Kumar is the recipient of several recognized awards and fellowships, including Alexander von Humboldt fellowship, DAAD & DGF scholarships. His research interests include Numerical solutions of integro-differential equations, numerical analysis and modelling and simulations of problem in particulate systems.

Course certificate

The course is free to enroll and learn from. But if you want a certificate, you have to register and write the proctored exam conducted by us in person at any of the designated exam centres.
The exam is optional for a fee of Rs 1000/- (Rupees one thousand only).
Date and Time of Exams: **03 November 2024** Morning session 9am to 12 noon; Afternoon Session 2pm to 5pm.
Registration url: Announcements will be made when the registration form is open for registrations.
The online registration form has to be filled and the certification exam fee needs to be paid. More details will be made available when the exam registration form is published. If there are any changes, it will be mentioned then.
Please check the form for more details on the cities where the exams will be held, the conditions you agree to when you fill the form etc.

CRITERIA TO GET A CERTIFICATE

Average assignment score = 25% of average of best 8 assignments out of the total 12 assignments given in the course.
Exam score = 75% of the proctored certification exam score out of 100

Final score = Average assignment score + Exam score

YOU WILL BE ELIGIBLE FOR A CERTIFICATE ONLY IF AVERAGE ASSIGNMENT SCORE >=10/25 AND EXAM SCORE >= 30/75. If one of the 2 criteria is not met, you will not get the certificate even if the Final score >= 40/100.

Certificate will have your name, photograph and the score in the final exam with the breakup.It will have the logos of NPTEL and IIT Kharagpur .It will be e-verifiable at nptel.ac.in/noc (http://nptel.ac.in/noc).

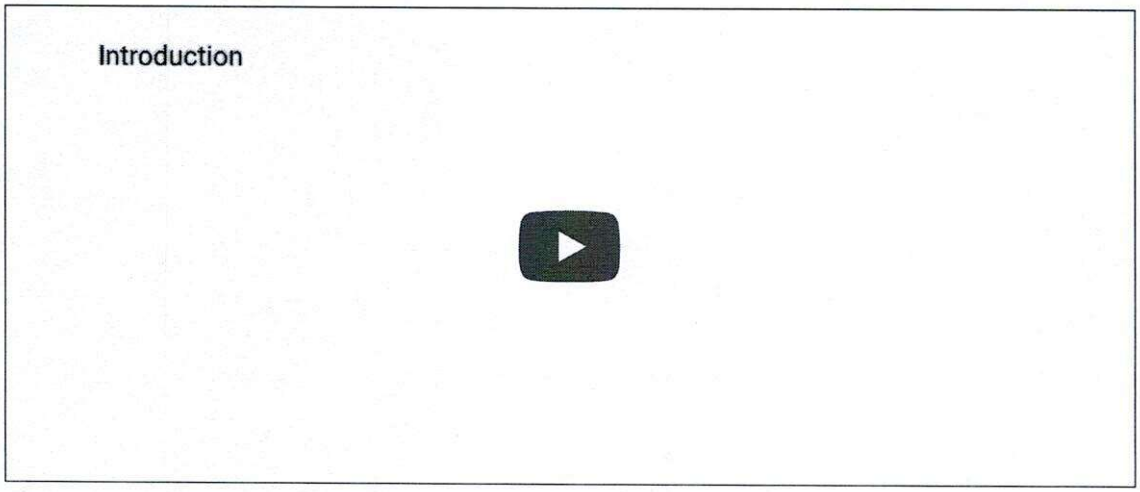
Only the e-certificate will be made available. Hard copies will not be dispatched.

Once again, thanks for your interest in our online courses and certification. Happy learning.

- NPTEL team

Advanced Calculus For Engineers

By Prof. Jitendra Kumar, Prof. Somesh Kumar | IIT Kharagpur



About The Course:

This course is about basic mathematics, which is a fundamental and essential component of all undergraduate studies in sciences and engineering. This course consists of topics in differential, integral, and vector calculus with applications to various engineering problems. This course will cover calculus of two or more variables in detail. Knowledge of ordinary differential equations are part of this course. Students will learn how to perform double and triple integrals. Topic in vector calculus includesline and surface integrals, Green, Gauss and Stokes theorem.

PRE-REQUISITES : Higher Secondary

INTENDED AUDIENCE: All branches of science and engineering

Summary

Course Status : Upcoming

Course Type :	Core (https://swayam.gov.in/nc_details/NPTEL)
Duration :	12 weeks
Category :	About Swayam (https://swayam.gov.in/about) | All Courses | Mathematics ()
Credit Points :	3
Level :	Undergraduate
Start Date :	22 Jul 2024
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Week 7: Higher order ODEs
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Week 9: Double integrals
Week 10: Triple Integrals
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Week 12: Line and surface integrals. Green, Stokes and Gauss divergence theorems

Books and references

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2. Kreyszig, E., Advanced Engineering Mathematics, 10th edition. John Wiley & Sons, 2010.
3. Thomas, G.B. and Finney, R.L., Calculus and Analytic Geometry, 9th Edition, Pearson, Reprint, 2002.

Instructor bio

Prof. Jitendra Kumar

IIT Kharagpur

Jitendra Kumar is an Associate Professor at the Department of Mathematics, IIT Kharagpur. He completed his M.Sc. in Industrial Mathematics from IIT Roorkee and Technical University of Kaiserslautern, Germany in 2001 and 2003, respectively. He received his PhD degree in 2006 from Otto-von-Guericke University Magdeburg, Germany. He was Research Associate at the Institute for Analysis and Numerical Mathematics, Otto-von-Guericke University Magdeburg, Germany from 2006 to 2009. Dr. Kumar is the recipient of several recognized awards and fellowships, including Alexander von Humboldt fellowship, DAAD & DGF scholarships. His research interests include Numerical solutions of integro-differential equations, numerical analysis and modelling and simulations of problem in particulate systems.

Prof. Somesh Kumar

Prof. Somesh Kumar is a professor in the Department of Mathematics, IIT Kharagpur. He has over 32 years of experience of teaching courses on Probability Statistics, Statistical Inference, Sampling Theory, Stochastic Processes, Multivariate Analysis, Regression Analysis, Time Series, Experimental Designs, Decision Theory to undergraduate, postgraduate and doctorate students. His NPTEL courses (under MHRD) on Probability and Statistics, Statistical Inference and Statistical Methods for Scientists and Engineers (each of 40 hours) are available online and very popular. He has also taught Mathematics-I in QEEE program of MHRD to 130 engineering college students in online mode during Autumn 2014-2015. He offered the course "Probability and Statistics" for certification program in Jan-April 2016, Jan-April 2017, Jan-April 2019. He also offered the course "Statistical Inference" for certification program during Jan-April 2019. His lectures on "Probability" and "Permutation and combinations" for class XII students under IIT-PAL scheme of MHRD are also available through DTH channels of national television.

His research interests are Statistical Decision Theory, Estimation Theory, Testing of Hypothesis, Classification Problems, Directional Distributions, Limit Theorems. He has published more than 100 research papers in refereed reputed international journals and book chapters. He has supervised eleven Ph.D. students and more than two hundred fifty Masters (M.Tech./ M.Sc./B.Tech.) dissertations.

He has been guest professor in University of Ulm, Germany in July 2017 and June-July 2018 and in University of Dortmund in May-June 2019. He is Principal Investigator for a major research project "Drone for Vaccine Delivery" funded by the Indian Council for Medical Research. He has delivered invited lectures in various universities in India and abroad.

Course certificate

The course is free to enroll and learn from. But if you want a certificate, you have to register and write the proctored exam conducted by us in person at any of the designated exam centres.
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- NPTEL team