छत्रपति शाहू जी महाराज विश्वविद्यालय, कानपुर

CHHATRAPATI SHAJU JI MAHARAJ UNIVERSITY, KANPUR

(पाठयक्रम समिति की बैठक की कार्यवाही)

दिनांक: **08.05.2021** की पुर्वान्ह : **11:00 AM** बजे **विज्ञानं**

संकाय के **गणित** विभाग **(विषय) हेतु पाठ्यक्रम समिति की बैठक की संस्तुतियां**

1. वर्तमान में प्रचलित पाठ्यक्रम में आवश्यकतानुसार संशोधन की संस्तुतियां

(अ) स्नातक पाठ्यक्रमः

BOS members, university representatives & special invitees from different colleges/universities (Ann-I) were present. NEP-2020 U.G. syllabus was discussed in detail, each and every member put up their opinion. The net outcome was that the NEP-2020 U.G. syllabus is good enough, compact and complete in optimized form covering all theoretical & practical aspects of the subject. It was decided that only minor changes are required. Accordingly, basic part of Mathematical statistics is incorporated in one unit of Mathematical Methods paper (SEM.-III, Paper-I,B-part, Unit-VIII) which is within permissible limit. Since Statistics is very useful in so many fields such as data analysis, operation research, forecasting and many other fields, hence Science students should know the basics of it so that they can use it & will help in getting job easily. Vocational/Elective courses such as Economics, Chemistry, Biochemistry, and Physics given in NEP-2020 UG syllabus &many other courses like I.T., CA, Electronics, Physical education, Statistics & Military Studies are already being opted by students in the colleges as per UGC norms.

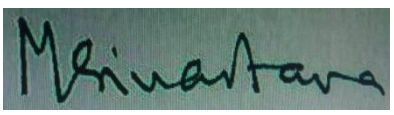
Regarding online courses/ MOOC Syllabus for Mathematics (vide-websites/Digital Library UP Govt., provided as below is added in the syllabus) - Differential & Partial differential equation, Differentiation & Integration, College Algebra, Matrix, Geometry, Mathematical Modeling, Numerical Analysis & Fourier Series, is already included in NEP 2020 UG Syllabus. Meeting was over at 12.00 noon.

The Convener has been unanimously authorized to submit the syllabus with little change.

*Various websites for online courses -

1) www.mooc-list.com>tags>mathe
2) https://www.edx.org/courses
3) www.ugc.ac.in
4) www/snuadmissions.com/bsc/mathematics
5) http://heecontent.upsdc.gov.in

2. आगामी परीक्षाओं हेतु प्रश्निों (Paper Setter), मूल्यांकन हेतु परीक्षकों एवं प्रायोगिक परीक्षाओं हेतु विषय विशेषज्ञों की अर्हता को ध्यान में रखते हए प्रश्न पत्र वार अर्ह शिक्षकों के नाम एवं पता मोबाइल नंबर के साथ पैनल का अनुमोदन



Dr. Meera Srivastava (Convener)

---------- Forwarded message ---------
From: **Rekha Bali** <rbali@hbtu.ac.in>
Date: Thu, May 13, 2021, 12:23 PM
Subject: Re: Document from Meera Srivastava
To: Meera Srivastava <dr.meerasrivastava05@gmail.com>

Dear Madam,
I have attended the BOS meeting (online) on 8,5,2021 and agreed with the changes as discussed in the meeting.

Regards
Prof. Rekha Bali
Mathematics department ,HBTU,Kanpur

On Wed, May 12, 2021 at 9:25 PM Meera Srivastava <dr.meerasrivastava05@gmail.com> wrote:

---------- Forwarded message ---------
From: **Meera Srivastava** <dr.meerasrivastava05@gmail.com>
Date: Wed, May 12, 2021, 8:19 PM
Subject: Document from Meera Srivastava
To: <dr.meerasrivastava05@gmail.com>

---------- Forwarded message ---------
From: **Pushpendra Tripathi** <pushpendratripathi1503@gmail.com>
Date: Thu, May 13, 2021, 12:24 PM
Subject: Syllabus meeting attendance
To: <dr.meerasrivastava05@gmail.com>

I was present in BOS Math virtual meeting on 8.5.21 and agreed with change in syllabus.

--------- Forwarded message ---------
From: **Dr C S Prasad Principal D B S College** <csprasd@gmail.com>
Date: Thu, May 13, 2021, 9:13 AM
Subject: Re: Document from Meera Srivastava
To: Meera Srivastava <dr.meerasrivastava05@gmail.com>

I was present in BOS meeting and agreed with the change.
Dr. C. S. Prasad

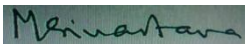
--------- Forwarded message ---------
From: **Arvind Kumar Sharma** <aksharma.maths@gmail.com>
Date: Thu, May 13, 2021, 10:44 AM
Subject: Re: Document from Meera Srivastava
To: Meera Srivastava <dr.meerasrivastava05@gmail.com>

I attended the meeting at 11am on 8/5/21. I agreed with all the changes in syllabus.

ANN.-1

Members present in BOS meeting:

BOS Members (Internal & External) -

1) Dr. Meera Srivastava (Convener) D.A-V College, Kanpur 
2) Dr. Rekha Bali (External) HBTI, Kanpur
3) Dr. C.S. Prasad (Member) DBS College, Kanpur
4) Dr. P.K. Tripathi (Member) D.A-V College, Kanpur
5) Dr. A.K.Sharma (Member) K.K.P.G. College, Etawah

University Representatives -

1) Dr. Varsha Gupta
2) Dr. Siddarth Mishra (special invitee from CSJMU)

SPECIAL INVITEES –

1) Dr. A.L.Pathak (special invitee) BND College, Kanpur
2) Dr. S.R.Verma (special invitee) D.A-V College, Kanpur
3) DR. Manjari Srivastava (special invitee) VSSD College, Kanpur
4) Dr. Maninder Singh Arora (special invitee) PPN College, Kanpur
5) Dr. Akhilesh Chandra Yadav (special invitee), Kashi Vidyapeeth , Varanasi

C.S.J.M. University, Kanpur
BOS Panel- Mathematics

Subject: Mathematics (30.01.2021)

1. Dr. Meera Srivastava, D.A.V. College, Kanpur **(Convenor).**
2. Prof. P. N. Pandey, Allahabad University, Allahabad.
3. Prof. Poonam Sharma, Lucknow University, Lucknow.
4. Prof. Jaya Upreti, S.S.J. Campus, Almora.
5. Dr. S. K. Khandelwal, Kamla Nagar, Agra.
6. Dr. P. K. Shukla, K.G.K., Moradabad.
7. Dr. Swadesh Singh, B.C., Bareilly.
8. Dr. Rekha Bali, H.B.T.U., Kanpur.
9. Dr. Chand Shekhar Prasad, D.B.S. College, Govind Nagar, Kanpur.
10. Dr. Pushpendra Kumar Tripathi, D.A.V. College, Kanpur.
11. Dr. Arvind Kumar Sharma, K.K.P.G. Collge, Etawah.

Syllabus for C.S.J.M. University, Kanpur (NEP-2020)
SUBJECT: MATHEMATICS

SEMESTER WISE TITLES OF THE PAPER IN UG MATHEMATICS COURSE					
YEAR	**SEMESTER**	**COURSE**	**PAPER TITLE**	**THEORY/PRACTICAL**	**CREDIT**
CERTIFICATE COURSE IN APPLIED MATHEMATICS					
FIRST YEAR	**I**	B030101T	Differential Calculus & Integral Calculus	THEORY	**4**
		B030102P	PRACTICAL	PRACTICAL	**2**
	II	B030201T	Matrices and Differential Equations & Geometry	THEORY	**6**
DIPLOMA IN MATHEMATICS					
SECOND YEAR	**III**	B030301T	Algebra & Mathematical Methods	THEORY	**6**
	IV	B030401T	Differential Equation & Mechanic	THEORY	**6**
DEGREE IN MATHEMATICS					
THIRD YEAR	**V**	B030501T	Group and Ring Theory & Linear Algebra	THEORY	**5**
		B030502T	Any One of The Following (i) Number Theory & Game Theory (ii) Graph Theory & Discrete Mathematics (iii) Differential Geometry & Tensor Analysis	THEORY	**5**
	VI	B030601T	Metric Space & Complex Analysis	THEORY	**4**
		B030602T	Numerical Analysis & Operations Research	THEORY	**4**
		B030603P	PRACTICAL	PRACTICAL	**2**

PROPOSED STRUCTURE OF UG MATHEMATICS SYLLABUS AS PER NEP 2020 GUIDELINES

GENERAL OVERVIEW

B.A./B.Sc. I

PROGRAMME	YEAR	SEMESTER (15 Weeks)	PAPER	CREDIT	PERIODS Per Week	PERIODS (HOURS)	PAPER TITLE	UNIT (Periods Per Semester)	PREREQUISITE	ELECTIVE (For Other Faculty)
CERTIFICATE COURSE IN APPLIED MATHEMATICS	FIRST YEAR	SEMESTER – I	**Paper-1**	4	4	4x 15= 60	**Differential Calculus & Integral Calculus** **Part A: Differential Calculus** **Part B: Integral Calculus**	**Part A** Unit I (9) Unit II (7) Unit III (7) Unit IV (7) **Part B** Unit V (9) Unit VI (7) Unit VII (7) Unit VIII (7)	Mathematics in 12th	Engg. and Tech. (UG), Chemistry/Biochemistry/ Life Sciences(UG), Economics(UG/PG), Commerce(UG), BBA/BCA, B.Sc.(C.S.)
			Paper-II Practical	2	2 Lab Periods(2 Hours Each)	2x2x 15= 60	**Practical** (Practicals to be done using Mathematica /MATLAB /Maple /Scilab/Maxima etc.)		Mathematics in 12th	Engg. and Tech. (UG), B.Sc.(C.S.)
		SEMESTER – II	**Paper-1**	6	6	6 x 15= 90	**Matrices and Differential Equations & Geometry** **Part A: Matrices and Differential Equations** **Part B: Geometry**	**Part A** Unit I (12) Unit II (11) Unit III (11) Unit IV (11) **Part B** Unit V (12) Unit VI (11) Unit VII (11) Unit VIII (11)	Mathematics in 12th	Engg. and Tech. (UG), B.Sc.(C.S.)

B.A./B.Sc. II

PROGRAMME	YEAR	SEMESTER (15 Weeks)	PAPER	CREDIT	PERIODS Per Week	PERIODS (HOURS)	PAPER TITLE	UNIT (Periods Per Semester)	PREREQUISITE	ELECTIVE (For Other Faculty)
DIPLOMA IN MATHEMATICS	SECOND YEAR	SEMESTER –III	Paper-1	6	6	6 x 15= 90	**Algebra & Mathematical Methods** **Part A: Algebra** **Part B: Mathematical Methods**	**Part A** Unit I (12) Unit II (11) Unit III (11) Unit IV (11) **Part B** Unit V (12) Unit VI (11) Unit VII (11) Unit VIII (11)	Certificate Course in Applied Mathematics	Engg. and Tech. (UG), B.Sc.(C.S.)
		SEMESTER – IV	Paper-1	6	6	6 x 15= 90	**Differential Equation & Mechanics** **Part A: Differential Equation** **Part B: Mechanics**	**Part A** Unit I (12) Unit II (11) Unit III (11) Unit IV (11) **Part B** Unit V (12) Unit VI (11) Unit VII (11) Unit VIII (11)	Certificate Course in Applied Mathematics	Engg. and Tech. (UG), Economics(UG/PG), B.Sc.(C.S.) Engineering and Technology (UG), Science (Physics-UG)

B.A./B.Sc. III

PROGRAMME	YEAR	SEMESTER (15 Weeks)	PAPER	CREDIT	PERIODS Per Week	PERIODS (HOURS) Per Semester	PAPER TITLE	UNIT (Periods Per Semester)	PREREQUISITE	ELECTIVE (For Other Faculty)
DEGREE IN MATHEMATICS	THIRD YERAR	SEMESTER – V	Paper-1	5	5	5x 15= 75	**Group and Ring Theory & Linear Algebra** **Part A: Group and Ring Theory** **Part B: Linear Algebra**	**Part A** Unit I (10) Unit II (10) Unit III (9) Unit IV (9) **Part B** Unit V (10) Unit VI (9) Unit VII (9) Unit VIII (9)	Certificate Course in Applied Mathematics	Engg. and Tech. (UG), Economics(UG/PG), B.Sc.(C.S.)
			Paper-2	5	5	5x 15= 75	**(i) Number Theory & Game Theory** **Part A: Number Theory** **Part B: Game Theory**	**Part A** Unit I (10) Unit II (9) Unit III (9) Unit IV (9) **Part B** Unit V (10) Unit VI (10) Unit VII (9) Unit VIII (9)	Diploma in Mathematics	Engg. and Tech.(UG), BCA, B.Sc.(C.S.)
							(ii) Graph Theory & Discrete Mathematics **Part A: Graph Theory** **Part B: Discrete Mathematics**	**Part A** Unit I (10) Unit II (9) Unit III (9) Unit IV (9) **Part B** Unit V (10) Unit VI (10) Unit VII (9) Unit VIII (9)	Diploma in Mathematics	Engg. and Tech. (UG), B.Sc.(C.S.)
							(iii) Differential Geometry & Tensor Analysis **Part A: Differential Geometry** **Part B: Tensor Analysis**	**Part A** Unit I (10) Unit II (9) Unit III (9) Unit IV (9) **Part B** Unit V (10) Unit VI (10) Unit VII (9) Unit VIII (9)	Diploma in Mathematics	Engg. and Tech. (UG), B.Sc.(C.S.)

		SEMESTER – VI	Paper-1	4	4	4 x 15= 60	**Metric Space** **&** **Complex Analysis** **Part A: Metric Space** **Part B: Complex Analysis**	**Part A** Unit I (8) Unit II (8) Unit III (7) Unit IV (7) **Part B** Unit V (8) Unit VI (8) Unit VII (7) Unit VIII (7)	Diploma in Mathematics	Engg. and Tech. (UG), B.Sc.(C.S.)
			Paper-2	4	4	4x 15= 60	**Numerical Analysis** **&** **Operations Research** **Part A: Numerical Analysis** **Part B: Operations Research**	**Part A** Unit I (8) Unit II (8) Unit III (7) Unit IV (7) **Part B** Unit V (8) Unit VI (8) Unit VII (7) Unit VIII (7)	Diploma in Mathematics	Engg. and Tech. (UG), Economics(UG/PG), BBA/BCA, B.Sc.(C.S.)
			Paper-III Practical	2	2 Lab Periods(2 Hours Each)	2x2x 15= 60	**Practical** (Practicals to be done using Mathematica /MATLAB /Maple /Scilab/Maxima etc.)		Diploma in Mathematics	Engg. and Tech. (UG), B.Sc.(C.S.)

B.A. /B.Sc. I (MATHEMATICS)

Detailed Syllabus For

CERTIFICATE COURSE

IN

APPLIED MATHEMATICS

B.A./B.Sc. I (SEMESTER-I) PAPER-I Differential Calculus & Integral Calculus

Programme: Certificate **Class: B.A./B.Sc.**	**Year: First**	**Semester: First**
Subject: Mathematics		
Course Code: B030101T	**Course Title: Differential Calculus & Integral Calculus**	

Credits: 4	**Core Compulsory / Elective**
Max. Marks: 25+75	**Min. Passing Marks:**
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0	

Part- A
Differential Calculus

Unit	Topics	No. of Lectures
I	**Introduction to Indian ancient Mathematics and Mathematicians should be included under Continuous Internal Evaluation (CIE).** Definition of a sequence, theorems on limits of sequences, bounded and monotonic sequences, Cauchy's convergence criterion, Cauchy sequence, limit superior and limit inferior of a sequence, subsequence, Series of non-negative terms, convergence and divergence, Comparison tests, Cauchy's integral test, Ratio tests, Root test, Raabe's logarithmic test, de Morgan and Bertrand's tests, alternating series, Leibnitz's theorem, absolute and conditional convergence.	**9**
II	Limit, continuity and differentiability of function of single variable, Cauchy's definition, Heine's definition, equivalence of definition of Cauchy and Heine, Uniform continuity, Borel's theorem, boundedness theorem, Bolzano's theorem, Intermediate value theorem, extreme value theorem, Darboux's intermediate value theorem for derivatives, Chain rule, indeterminate forms.	**7**
III	Rolle's theorem, Lagrange and Cauchy Mean value theorems, mean value theorems of higher order, Taylor's theorem with various forms of remainders, Successive differentiation, Leibnitz theorem, Maclaurin's and Taylor's series, Partial differentiation, Euler's theorem on homogeneous function.	**7**
IV	Tangent and normals, Asymptotes, Curvature, Envelops and evolutes, Tests for concavity and convexity, Points of inflexion, Multiple points, Parametric representation of curves and tracing of parametric curves, Tracing of curves in Cartesian and Polar forms.	**7**

Part-B
Integral Calculus

Unit	Topics	No. of Lectures
V	Definite integrals as limit of the sum, Riemann integral, Integrability of continuous and monotonic functions, Fundamental theorem of integral calculus, Mean value theorems of integral calculus, Differentiation under the sign of Integration.	9
VI	Improper integrals, their classification and convergence, Comparison test, μ-test, Abel's test, Dirichlet's test, quotient test, Beta and Gamma functions.	7
VII	Rectification, Volumes and Surfaces of Solid of revolution, Pappus theorem, Multiple integrals, change of order of double integration, Dirichlet's theorem, Liouville's theorem for multiple integrals.	7
VIII	Vector Differentiation, Gradient, Divergence and Curl, Normal on a surface, Directional Derivative, Vector Integration, Theorems of Gauss, Green, Stokes and related problems.	7

Suggested Readings (Part- A Differential Calculus):

1. R.G. Bartle & D.R. Sherbert, Introduction to Real Analysis, John Wiley & Sons
2. T.M. Apostal, Calculus Vol. I, John Wiley & Sons Inc.
3. S. Balachandra Rao & C. K. Shantha, Differential Calculus, New Age Publication.
4. H. Anton, I. Birens and S. Davis, Calculus, John Wiley and Sons, Inc., 2002.
5. G.B. Thomas and R.L. Finney, Calculus, Pearson Education, 2007.
6. Suggestive digital platforms web links: NPTEL/SWAYAM/MOOCS, www.mooc-list.com/tags/mathe, http://heecontent.upsdc.gov.in/
7. Course Books published in Hindi may be prescribed by the Universities.

Suggested Readings (Part-B Integral Calculus):

1. T.M. Apostal, Calculus Vol. II, John Wiley Publication
2. Shanti Narayan & Dr. P.K. Mittal, Integral Calculus, S.Chand
3. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons.
4. Suggestive digital platforms web links: NPTEL/SWAYAM/MOOCS, www.mooc-list.com/tags/mathe, http://heecontent.upsdc.gov.in/
5. Course Books published in Hindi may be prescribed by the Universities.

This course can be opted as an elective by the students of following subjects: Engg. and Tech. (UG), Chemistry/Biochemistry/Life Sciences(UG), Economics(UG/PG), Commerce(UG), BBA/BCA, B.Sc.(C.S.)

Suggested Continuous Evaluation Methods: Max. Marks: 25

SN	Assessment Type	Max. Marks
1	**Class Tests**	10
2	**Online Quizzes/ Objective Tests**	5
3	**Presentation**	5
4	**Assignment (Introduction to Indian ancient Mathematics and Mathematicians).**	5

Course prerequisites: To study this course, a student must have subject Mathematics in class 12th

Suggested equivalent online courses: https://www.edx.org, https://www.coursera.org/courses, https://www.ugc.ac.in/, www.snuadmissions.com/bsc/mathematics.

Further Suggestions:

B.A./B.Sc. I (SEMESTER-I) Paper-II Practical

Programme: Certificate **Class: B.A./B.Sc.**	**Year: First**	**Semester: First**
Subject: Mathematics		
Course Code: B030102P	**Course Title: Practical**	
Credits: 2	**Core Compulsory / Elective**	
Max. Marks: 25+75	**Min. Passing Marks:**	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 0-0-4		

Unit	Topics	No. of Lectures
	Practical / Lab work to be performed in Computer Lab. List of the practicals to be done using Mathematica /MATLAB /Maple /Scilab/Maxima etc. 1. Plotting the graphs of the following functions: (i) ax (ii) [x] (greatest integer function) (iii) x^{2n} ; $n \in N$ (iv) x^{2n-1} ; $n \in N$ (v) $\frac{1}{x^{2n-1}}$;$n \in N$ (vi) $\frac{1}{x^{2n}}$;$n \in N$ (vii) $\sqrt{ax+b}$, $\lvert ax+b \rvert$, $c \pm \lvert ax+b \rvert$ (ix) $\frac{\lvert x \rvert}{x}$, $\sin\left(\frac{1}{x}\right)$, $x \sin\left(\frac{1}{x}\right)$, e^{x}, e^{-x} for $x \neq 0$. (x) $e^{ax+b}, \log(ax+b), \frac{1}{ax+b}, \sin(ax+b), \cos(ax+b), \lvert \sin(ax+b) \rvert, \lvert \cos(ax+b) \rvert$. Observe and discuss the effect of changes in the real constants a and b on the graphs. (2) By plotting the graph find the solution of the equation $x = e^{x}, x^{2}+1 = e^{x}, 1-x^{2} = e^{x}, x = \log_{10}(x), \cos(x) = x, \sin(x) = x, \cos(y) = \cos(x), \sin(y) = \sin(x)$ etc (3) Plotting the graphs of polynomial of degree 2,3, 4 and 5, and their first and second derivatives.	

	(4) Sketching parametric curves, e.g., Trochoid, Cycloid, Epicycloid and Hypocycloid etc. (5) Tracing of conic in Cartesian coordinates. (6) Graph of circular and hyperbolic functions. (7) Obtaining surface of revolution of curves. (8) Complex numbers and their representations, Operations like addition, Multiplication, Division, Modulus. Graphical representation of polar form. (9) Find numbers between two real numbers and plotting of finite and infinite subset of R. (10) Matrix Operations: Addition, Multiplication, Inverse, Transpose, Determinant, Rank, Eigenvectors, Eigenvalues, Characteristic equation and verification of the Cayley-Hamilton theorem, Solving the systems of linear equations. (11) Study the convergence of sequences through plotting. (12)Verify Bolzano-Weierstrass theorem through plotting of sequences and hence identify convergent subsequences from theplot. (13)Study the convergence/divergence of infinite series by plotting their sequences of partial sum. (14) Cauchy's root test by plotting *n*-th roots. (15) Ratio test by plotting the ratio of *n*-th and (*n* + 1)-th term.	

Suggested Readings

This course can be opted as an elective by the students of following subjects: Engg. and Tech. (UG), Chemistry/Biochemistry/Life Sciences(UG), Economics(UG/PG), Commerce(UG), BBA/BCA, B.Sc.(C.S.)

Suggested Continuous Evaluation Methods: Max. Marks: 25

SN	Assessment Type	Max. Marks
1	**Class Tests**	**10**
2	**Online Quizzes/ Objective Tests**	**5**
3	**Presentation**	**5**
4	**Assignment**	**5**

Course prerequisites: To study this course, a student must have subject Mathematics in class 12th

Suggested equivalent online courses: https://www.edx.org, https://www.coursera.org/courses, https://www.ugc.ac.in/, www.snuadmissions.com/bsc/mathematics.

Further Suggestions:

B.A./B.Sc. I (SEMESTER-II) PAPER-I Matrices and Differential Equations & Geometry

Programme: Certificate **Class: B.A./B.Sc.**	**Year: First**	**Semester: Second**
Subject: Mathematics		
Course Code: B030201T	**Course Title: Matrices and Differential Equations & Geometry**	
Credits: 6	**Core Compulsory / Elective**	
Max. Marks: 25+75	**Min. Passing Marks:**	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 6-0-0		

PART-A
Matrices and Differential Equations

Unit	Topics	No. of Lectures
I	Types of Matrices, Elementary operations on Matrices, Rank of a Matrix, Echelon form of a Matrix, Normal form of a Matrix, Inverse of a Matrix by elementary operations, System of linear homogeneous and non-homogeneous equations, Theorems on consistency of a system of linear equations.	**12**
II	Eigen values, Eigen vectors and characteristic equation of a matrix, Caley-Hamilton theorem and its use in finding inverse of a matrix, Complex functions and separation into real and imaginary parts, Exponential and Logarithmic functions Inverse trigonometric and hyperbolic functions.	**11**
III	Formation of differential equations, Geometrical meaning of a differential equation, Equation of first order and first degree, Equation in which the variables are separable, Homogeneous equations, Exact differential equations and equations reducible to the exact form, Linear equations.	**11**
IV	First order higher degree equations solvable for x, y, p, Clairaut's equation and singular solutions, orthogonal trajectories, Linear differential equation of order greater than one with constant coefficients, Cauchy- Eulerform.	**11**

PART-B

Geometry

Unit	Topics	No. of Lectures
V	General equation of second degree, System of conics, Tracing of conics, Confocal conics, Polar equation of conics and its properties.	**12**
VI	Three-Dimensional Coordinates, Projection and Direction Cosine, Plane (Cartesian and vector form), Straight line in three dimension.	**11**
VII	Sphere, Cone and Cylinder.	**11**
VIII	Central conicoids, Paraboloids, Plane section of conicoids, Generating lines, Confocal conicoids, Reduction of second degree equations.	**11**

Suggested Readings (PART-A Matrices and Differential Equations):

1. Stephen H. Friedberg, A.J Insel & L.E. Spence, Linear Algebra, Person
2. B. Rai, D.P. Choudhary & H. J. Freedman, A Course in Differential Equations, Narosa
3. D.A. Murray, Introductory Course in Differential Equations, Orient Longman
4. Suggested digital plateform:NPTEL/SWAYAM/MOOCs, www.mooc-list.com/tags/mathe, http://heecontent.upsdc.gov.in/
5. Course Books published in Hindi may be prescribed by the Universities.

Suggested Readings (Part-B Geometry):

1. Robert J.T Bell, Elementary Treatise on Coordinate Geometry of three dimensions, Macmillan India Ltd.
2. P.R. Vittal, Analytical Geometry 2d & 3D, Pearson.
3. S.L. Loney, The Elements of Coordinate Geometry, McMillan and Company, London.
4. R.J.T. Bill, Elementary Treatise on Coordinate Geometry of Three Dimensions, McMillan India Ltd., 1994.
5. Suggested digital plateform:NPTEL/SWAYAM/MOOCs, www.mooc-list.com/tags/mathe, http://heecontent.upsdc.gov.in/
6. Course Books published in Hindi may be prescribed by the Universities.

This course can be opted as an elective by the students of following subjects: Engg. and Tech. (UG), Economics(UG/PG), Commerce(UG), BBA/BCA, B.Sc.(C.S.)

Suggested Continuous Evaluation Methods: Max. Marks: 25

SN	Assessment Type	Max. Marks
1	**Class Tests**	**10**
2	**Online Quizzes/ Objective Tests**	**5**
3	**Presentation**	**5**
4	**Assignment**	**5**

Course prerequisites: To study this course, a student must have subject Mathematics in class 12th

Suggested equivalent online courses: https://www.edx.org, https://www.coursera.org/courses, https://www.ugc.ac.in/, www.snuadmissions.com/bsc/mathematics.

Further Suggestions:

B.A. /B.Sc. II (MATHEMATICS)

Detailed Syllabus For

DIPLOMA
IN
MATHEMATICS

B.A./B.Sc.II (SEMESTER-III) PAPER-I Algebra & Mathematical Methods

Programme: Diploma **Class: B.A./B.Sc.**	**Year: Second**	**Semester: Third**
Subject: Mathematics		
Course Code: B030301T	**Course Title: Algebra & Mathematical Methods**	
Credits: 6	**Core Compulsory / Elective**	
Max. Marks: 25+75	**Min. Passing Marks:**	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 6-0-0		

Part- A

Algebra

Unit	Topics	No. of Lectures
I	**Introduction to Indian ancient Mathematics and Mathematicians should be included under Continuous Internal Evaluation (CIE).** Equivalence relations and partitions, Congruence modulo n, Definition of a group with examples and simple properties, Subgroups, Generators of a group, Cyclic groups.	**12**
II	Permutation groups, Even and odd permutations, The alternating group, Cayley's theorem, Direct products, Coset decomposition, Lagrange's theorem and its consequences, Fermat and Euler theorems	**11**
III	Normal subgroups, Quotient groups, Homomorphism and isomorphism, Fundamental theorem of homomorphism, Theorems on isomorphism.	**11**
IV	Rings, Subrings, Integral domains and fields, Characteristic of a ring, Ideal and quotient rings, Ring homomorphism, Field of quotient of an integral domain.	**11**

Part- B
Mathematical Methods

Unit	Topics	No. of Lectures
V	Limit and Continuity of functions of two variables, Differentiation of function of two variables, Necessary and sufficient condition for differentiability of functions two variables, Schwarz's and Young theorem, Taylor's theorem for functions of two variables with examples, Maxima and minima for functions of two variables, Lagrange multiplier method, Jacobians.	**12**
VI	Existence theorems for Laplace transforms, Linearity of Laplace transform and their properties, Laplace transform of the derivatives and integrals of a function, Convolution theorem, inverse Laplace transforms, Solution of the differential equations using Laplace transforms.	**11**
VII	Fourier series, Fourier expansion of piecewise monotonic functions, Half and full range expansions, Fourier transforms (finite and infinite), Fourier integral.	**11**
VIII	Mathematical Statistics- Probability, Theoretical distributions (Binomial, Poisson and Normal), Curve fitting, Correlation, Regression.	**11**

Suggested Readings(Part-A Algebra):

1. J.B. Fraleigh, A first course in Abstract Algebra, Addison-weley
2. I. N. Herstein, Topics in Algebra, John Wiley & Sons
3. Suggested digital plateform: NPTEL/SWAYAM/MOOCS, www.mooc-list.com/tags/mathe, http://heecontent.upsdc.gov.in/
4. Course Books published in Hindi may be prescribed by the Universities.

Suggested Readings (Part- B Mathematical Methods):

1. T.M. Apostal, Mathematical Analysis, Pearson
2. G.F. Simmons, Differential Equations with Application and Historical Notes, Tata -McGrawHill
3. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons.
4. Suggested digital plateform:NPTEL/SWAYAM/MOOCs, www.mooc-list.com/tags/mathe, http://heecontent.upsdc.gov.in/
5. Course Books published in Hindi may be prescribed by the Universities.

This course can be opted as an elective by the students of following subjects: Engg. and Tech. (UG), B.Sc.(C.S.)

Suggested Continuous Evaluation Methods: Max. Marks: 25

SN	Assessment Type	Max. Marks
1	**Class Tests**	**10**
2	**Online Quizzes/ Objective Tests**	**5**
3	**Presentation**	**5**
4	**Assignment (Introduction to Indian ancient Mathematics and Mathematicians)**	**5**

Course prerequisites: To study this course, a student must have subject Mathematics in class 12th

Suggested equivalent online courses: https://www.edx.org, https://www.coursera.org/courses, https://www.ugc.ac.in/, www.snuadmissions.com/bsc/mathematics.

Further Suggestions:

B.A./B.Sc. II (SEMESTER-IV) PAPER-I Differential Equations & Mechanics

Programme: Diploma **Class: B.A./B.Sc.**	**Year: Second**	**Semester: Fourth**
Subject: Mathematics		
Course Code: B030401T	**Course Title: Differential Equations & Mechanics**	
Credits: 6	**Core Compulsory / Elective**	
Max. Marks: 25+75	**Min. Passing Marks:**	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 6-0-0		

Part- A

Differential Equations

Unit	Topics	No. of Lectures
I	Second order linear differential equations with variable coefficients: Use of a known solution to find another, normal form, method of undetermined coefficient, variation of parameters, Series solutions of differential equations, Power series method.	**12**
II	Bessel, Legendre and Hypergeometric functions and their properties, recurrence and generating relations.	**11**
III	Origin of first order partial differential equations. Partial differential equations of the first order and degree one, Lagrange's solution, Partial differential equation of first order and degree greater than one. Charpit's method of solution, Surfaces Orthogonal to the given system of surfaces.	**11**
IV	Origin of second order PDE, Solution of partial differential equations of the second and higher order with constant coefficients, Classification of linear partial differential equations of second order, Solution of second order partial differential equations with variable coefficients, Monge's method of solution.	**11**

Part- B

Mechanics

Unit	Topics	No. of Lectures
V	Frame of reference, work energy principle, Forces in three dimensions, Poinsot's central axis, Wrenches, Null lines and planes.	**12**
VI	Virtual work, Stable and Unstable equilibrium, Catenary, Catenary of uniform strength.	**11**
VII	Velocities and accelerations along radial and transverse directions, and along tangential and normal directions, Simple Harmonic motion, Motion under other law of forces. Elastic strings, Motion in resisting medium, Constrained motion, Motion on smooth and rough plane curves.	**11**
VIII	Motion of particles of varying mass, Rocket motion, Central orbit, Kepler's laws of motion, Motion of particle in three dimensions, Rotating frame of reference, Rotating Earth, Acceleration in terms of different coordinates systems.	**11**

Suggested Readings(Part-A Differential Equations):

1. G.F. Simmons, Differential Equations with Application and Historical Notes, Tata –McGrawHill
2. B. Rai, D.P. Choudhary & H. J. Freedman, A Course of Ordinary Differential Equations, Narosa
3. Ian N. Snedden, Elements of Partial Differential Equations, Dover Publication
4. L.E. Elsgolts, Differential Equation and Calculus of variations, University Press of the Pacific.
5. Suggested digital plateform:NPTEL/SWAYAM/MOOCs, www.mooc-list.com/tags/mathe, http://heecontent.upsdc.gov.in/
6. Course Books published in Hindi may be prescribed by the Universities.

Suggested Readings(Part-B Mechanics):

1. R.C. Hibbeler, Engineering Mechanics-Statics, Prentics Hall Publishers
2. R.C. Hibbeler, Engineering Mechanics-Dynamics, Prentics Hall Publishers
3. A. Nelson, Engineering Mechanics Statics and Dynamics, Tata McGraw Hill
4. J.L. Synge & B.A. Griffith, Principles of Mechanics, Tata McGraw Hill
5. Suggested digital plateform:NPTEL/SWAYAM/MOOCs, www.mooc-list.com/tags/mathe, http://heecontent.upsdc.gov.in/
6. Course Books published in Hindi may be prescribed by the Universities.

This course can be opted as an elective by the students of following subjects: Engg. and Tech. (UG), Economics(UG/PG), B.Sc.(C.S.)

Suggested Continuous Evaluation Methods: Max. Marks: 25

SN	Assessment Type	Max. Marks
1	**Class Tests**	**10**
2	**Online Quizzes/ Objective Tests**	**5**
3	**Presentation**	**5**
4	**Assignment**	**5**

Course prerequisites: To study this course, a student must have Certificate Course in Applied Mathematics

Suggested equivalent online courses: https://www.edx.org, https://www.coursera.org/courses, https://www.ugc.ac.in/, www.snuadmissions.com/bsc/mathematics.

Further Suggestions:

B.A. /B.Sc. III (MATHEMATICS)

Detailed Syllabus For

DEGREE
IN
MATHEMATICS

B.A./B.Sc. III (SEMESTER-V) PAPER-I Group and Ring Theory & Linear Algebra

Programme: Degree **Class: B.A./B.Sc.**	**Year: Third**	**Semester: Fifth**
Subject: Mathematics		
Course Code: B030501T	**Course Title: Group and Ring Theory & Linear Algebra**	
Credits: 5	**Core Compulsory / Elective**	
Max. Marks: 25+75	**Min. Passing Marks:**	

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 5-0-0

PART-A

Group and Ring Theory

Unit	Topics	No. of Lectures
I	**Introduction to Indian ancient Mathematics and Mathematicians should be included under Continuous Internal Evaluation (CIE).** Automorphism, inner automorphism, Automorphism groups, Automorphism groups of finite and infinite cyclic groups, Characteristic subgroups, Commutator subgroup and its properties; Applications of factor groups to automorphismgroups.	**10**
II	Conjugacy classes, The class equation, *p*-groups, The Sylow theorems and consequences, Applications of Sylow theorems; Finite simple groups, Nonsimplicity tests; Generalized Cayley's theorem, Index theorem, Embedding theorem and applications.	**10**
III	Polynomial rings over commutative rings, Division algorithm and consequences, Principal ideal domains, Factorization of polynomials, Reducibility tests, Irreducibility tests, Eisenstein criterion, Unique factorization in Z[x].	**9**
IV	Divisibility in integral domains, Irreducibles, Primes, Unique factorization domains, Euclidean domains.	**9**

PART-B

Linear Algebra

Unit	Topics	No. of Lectures
V	Vector spaces, Subspaces, Linear independence and dependence of vectors, Basis and Dimension, Quotient space.	**10**
VI	Linear transformations, The Algebra of linear transformations, rank nullity theorem, their representation as matrices.	**9**
VII	Linear functionals, Dual space, Characteristic values, Cayley HamiltonTheorem.	**9**
VIII	Inner product spaces and norms, Cauchy-Schwarz inequality, Orthogonal vectors, Orthonormal sets and bases, Bessel's inequality for finite dimensional spaces, Gram-Schmidt orthogonalization process, Bilinear and Quadratic forms.	**9**

Suggested Readings:

1. Topics in Algebra by I. N. Herstein.

2. Linear Algebra by K. Hoffman and R. Kunze.

3. Suggested digital plateform:NPTEL/SWAYAM/MOOCs, www.mooc-list.com/tags/mathe, http://heecontent.upsdc.gov.in/

4. Course Books published in Hindi may be prescribed by the Universities.

This course can be opted as an elective by the students of following subjects: Engg. and Tech. (UG), BCA, B.Sc.(C.S.)

Suggested Continuous Evaluation Methods: Max. Marks: 25

SN	Assessment Type	Max. Marks
1	**Class Tests**	**10**
2	**Online Quizzes/ Objective Tests**	**5**
3	**Presentation**	**5**
4	**Assignment (Introduction to Indian ancient Mathematics and Mathematicians)**	**5**

Course prerequisites: To study this course, a student must have Diploma in Mathematics

Suggested equivalent online courses: https://www.edx.org, https://www.coursera.org/courses, https://www.ugc.ac.in/, www.snuadmissions.com/bsc/mathematics.

Further Suggestions:

B.A./B.Sc. III (SEMESTER-V) PAPER-II (i) Number Theory & Game Theory

Programme: Degree **Class: B.A./B.Sc.**	**Year: Third**	**Semester: Sixth**
Subject: Mathematics		
Course Code: B030502T	**Course Title: Number Theory & Game Theory**	
Credits: 5	**Core Compulsory / Elective**	
Max. Marks: 25+75	**Min. Passing Marks:**	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 5-0-0		

Part- A

Number Theory

Unit	Topics	No. of Lectures
I	**Theory of Numbers** Divisibility; Euclidean algorithm; primes; congruences; Fermat's theorem, Euler's theorem and Wilson's theorem; Fermat's quotients and their elementary consequences; solutions of congruences; Chinese remainder theorem; Euler's phi-function.	**10**
II	**Congruences** Congruence modulo powers of prime; primitive roots and their existence; quadratic residues; Legendre symbol, Gauss' lemma about Legendre symbol; quadratic reciprocity law; proofs of various formulations; Jacobi symbol.	**9**
III	**Diophantine Equations** Solutions of ax + by = c, $x^n + y^n = z^n$; properties of Pythagorean triples; sums of two, four and five squares; assorted examples of diophantine equations.	9
IV	**Generating Functions and Recurrence Relations** Generating Function Models, Calculating coefficient of generating functions, Partitions, Exponential Generating Functions, A Summation Method. Recurrence Relations: Recurrence Relation Models, Divide and conquer Relations, Solution of Linear, Recurrence Relations, Solution of Inhomogeneous Recurrence Relations, Solutions with Generating Functions.	**9**

Part- B
Game Theory

Unit	Topics	No. of Lectures
V	Introduction, overview, uses of game theory, some applications and examples, and formal definitions of: the normal form, payoffs, strategies, pure strategy Nash equilibrium.	10
VI	Introduction, characteristic of game theory, Two- person zero-sum game, Pure and Mixed strategies, Saddle point and its existence.	10
VII	Fundamental Theorem of Rectangular games, Concept of Dominance, Dominance and Graphical method of solving Rectangular games.	9
VIII	Relationship between rectangular game and Linear Programming Problem, Solving rectangular game by Simplex method, reduction of m x n game and solution of 2x2, 2 x s, and r x 2 cases by graphical method, algebraic and linear programming solution of m x n games.	9

Suggested Readings (Part-A Number Theory):

1. Niven, I., Zuckerman, H. S. and Montegomery, H. L. (2003) An Int. to the Theory of Numbers (6th edition) John Wiley and sons, Inc., New York.
2. Burton, D. M. (2002) Elementary Number Theory (4th edition) Universal Book Stall, New Delhi.
3. Balakrishnan, V. K. (1994) Schaum's Outline of Theory and Problems of Combinatorics Including Concepts of Graph Theory, Schaum's Outline.
4. Balakrishnan,V. K. (1996) Introductory Discrete Mathematics, Dover Publications.
5. Suggested digital plateform:NPTEL/SWAYAM/MOOCs, www.mooc-list.com/tags/mathe, http://heecontent.upsdc.gov.in/
6. Course Books published in Hindi may be prescribed by the Universities.

Suggested Readings (Part-B Game Theory):

1. Martin Osborne, An Introduction to Game Theory, Oxford University Press, 2003
2. Vijay Krishna, Game Theory, Academic Press.
3. Prajit Dutta, Strategies and Games, MIT Press, (Website 1) http://www.ece.stevens-tech.edu/~ccomanic/ee800c.html
5. Allan MacKenzie, Game Theory for Wireless Engineers, Synthesis lectures on Communications, 2006
6. Suggested digital plateform:NPTEL/SWAYAM/MOOCS, www.mooc-list.com/tags/mathe, http://heecontent.upsdc.gov.in/
7. Course Books published in Hindi may be prescribed by the Universities.

This course can be opted as an elective by the students of following subjects: Engg. and Tech. (UG), B.Sc.(C.S.)

Suggested Continuous Evaluation Methods: Max. Marks: 25

SN	Assessment Type	Max. Marks
1	**Class Tests**	**10**
2	**Online Quizzes/ Objective Tests**	**5**
3	**Presentation**	**5**
4	**Assignment**	**5**

Course prerequisites: To study this course, a student must have Diploma in Mathematics

Suggested equivalent online courses: https://www.edx.org, https://www.coursera.org/courses, https://www.ugc.ac.in/, www.snuadmissions.com/bsc/mathematics.

Further Suggestions:

B.A./B.Sc. III (SEMESTER-V) PAPER-II (ii) Graph Theory & Discrete Mathematics

Programme: Degree **Class: B.A./B.Sc.**	**Year: Third**	**Semester: Sixth**
Subject: Mathematics		
Course Code: B030502T	**Course Title: Graph Theory & Discrete Mathematics**	
Credits: 5	**Core Compulsory / Elective**	
Max. Marks: 25+75	**Min. Passing Marks:**	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 5-0-0		

Part- A

Graph Theory

Unit	Topics	No. of Lectures
I	Introduction to graphs, basic properties of graphs, Simple graph, multi graph, graph terminology, representation of graphs, Bipartite, regular, planar and connected graphs, connected components in a graph, Euler graphs, Directed, Undirected, multi-graph, mixed graph.	**10**
II	Walk and unilateral components, unicursal graph, Hamiltonian path and circuits, Graph colouring, chromatics number, isomorphism and homomorphism of graphs, Incidence relation and degree of the graph.	**9**
III	Operation of graph circuit, Path and circuits, Eulerian circuits, Hamiltonian path and cycles, Adjacency matrix, Weighted graph, Travelling salesman problem, Shortest path, Dijkstra's algorithm.	**9**
IV	Tree, Binary and Spanning trees, Coloring, Color problems, Vertex coloring and important properties.	**9**

Part- B
Discrete Mathematics

Unit	Topics	No. of Lectures
V	**Propositional Logic-** Proposition logic, basic logic, logical connectives, truth tables, tautologies, contradiction, normal forms (conjunctive and disjunctive), modus ponens and modus tollens, validity, predicate logic, universal and existential quantification, proof by implication, converse, inverse contrapositive, contradiction, direct proof by using truthtable. **Relation-** Definition, types of relation, domain and range of a relation, pictorial representation of relation, properties of relation, partial ordering relation.	**10**
VI	**Boolean Algebra-** Basic definitions, Sum of products and products of sums, Logic gates and Karnaugh maps. **Graphs-** Simple graph, multi graph, graph terminology, representation of graphs, Bipartite, regular, planar and connectedgraphs, connected components in a graph, Euler graphs, Hamiltonian path and circuits, Graph colouring, chromatics number, isomorphism and homomorphism of graphs.	**10**
VII	**Combinatories-** Inclusion- exclusion, recurrence relations (nth order recurrence relation with constant coefficients, Homogeneous recurrence relations, Inhomogeneous recurrence relations), generating function (closed form expression, properties of G.F., solution of recurrence relations using G.F. solution of combinatorial problem using G.F.)	**9**
VIII	**Finite Automata-** Basic concepts of automation theory, Deterninistic Finite Automation (DFA), transition function, transition table, Non Deterministic Finite Automata (NDFA), Mealy and Moore machine, Minimization of finite automation.	**9**

Suggested Readings (Part-A Graph Theory):

1. "Graph Theory with Applications to Engineering and Computer Science" by Narsingh Deo
2. "Introduction to Graph Theory" by Douglas B West
3. "Graph Theory with Algorithms and Its Applications: In Applied Science and Technology" by Santanu Saha Ray
4. Suggested digital plateform:NPTEL/SWAYAM/MOOCs, www.mooc-list.com/tags/mathe, http://heecontent.upsdc.gov.in/
5. Course Books published in Hindi may be prescribed by the Universities.

Suggested Readings (Part-B Discrete Mathematics):

1. Discrete Mathematics by C. L.Liu.
2. Discrete Mathematics with computer application by Trembley and Manohar.
3. Discrete Mathematics and Its Applications by Kenneth H. Rosen
4. Suggested digital plateform:NPTEL/SWAYAM/MOOCS, www.mooc-list.com/tags/mathe, http://heecontent.upsdc.gov.in/
5. Course Books published in Hindi may be prescribed by the Universities.

This course can be opted as an elective by the students of following subjects: Engg. and Tech. (UG), B.Sc.(C.S.)

Suggested Continuous Evaluation Methods: Max. Marks: 25

SN	Assessment Type	Max. Marks
1	**Class Tests**	**10**
2	**Online Quizzes/ Objective Tests**	**5**
3	**Presentation**	**5**
4	**Assignment**	**5**

Course prerequisites: To study this course, a student must have Diploma in Mathematics

Suggested equivalent online courses: https://www.edx.org, https://www.coursera.org/courses, https://www.ugc.ac.in/, www.snuadmissions.com/bsc/mathematics.

Further Suggestions:

B.A./B.Sc. III (SEMESTER-V) PAPER-II (iii) Differential Geometry & Tensor Analysis

Programme: Degree **Class: B.A./B.Sc.**	**Year: Third**	**Semester: Sixth**
Subject: Mathematics		
Course Code: B030502T	**Course Title: Differential Geometry & Tensor Analysis**	

Credits: 5	**Core Compulsory / Elective**
Max. Marks: 25+75	**Min. Passing Marks:**

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 5-0-0

Part- A

Differential Geometry

Unit	Topics	No. of Lectures
I	Local theory of curves-Space curves, Examples, Plane Curves, tangent and normal and binormal, Osculating Plane, normal plane and rectifying plane, Osculating circle, osculating sphere Helices, Serret-Frenet apparatus, contact between curve and surfaces, tangent surfaces, involutes and evolutes of curves, Bertrand curves, Intrinsic equations, fundamental existence theorem for space curves.	**10**
II	Local Theory of Surfaces- Parametric patches on surface curve of a surface, family of surfaces (one parameter), edge of regression, rues surfaces, skew ruled surfaces and developable surfaces, surfaces of revolution, Helicoids.	**9**
III	Metric-first fundamental form and arc length, Direction coefficients, families of curves, intrinsic properties, geodesics, canonical geodesic equations, normal properties of geodesics, geodesics curvature, Geodesic polars.	**9**
IV	Gauss-Bonnet theorem, curvature of curves on surfaces, Gaussian curvature, normal curvature, Meusneir's theorem, mean curvature, Gaussian curvature, umbilic points, lines of curvature, Rodrigue's formula, Euler'stheorem.	**9**

Part- B
Tensor Analysis

Unit	Topics	No. of Lectures
V	Tensor algebra: Vector spaces, the dual spaces, tensor product of vector spaces, transformation formulae, contraction, special tensors- symmetric tensor, inner product, associated tensor with examples.	10
VI	Tensor Analysis: Contravariant and covariant vectors and tensors, Mixed tensors, Symmetric and skew-symmetric tensors, Algebra of tensors, Contraction and inner product, Quotient theorem, Reciprocal tensors, Christoffel's symbols, Law of transformation of Christoffel's symbols, Covariant differentiation, non- commutativity of Covariantderivative.	10
VII	Gradient of scalars, Divergence of a contravariant vector, covariant vector and conservative vectors, Laplacian of an invariant, curl of a covariant vector, irrotational vector, with examples.	9
VIII	Riemannian space, Riemannian curvatures and their properties, geodesics, geodesic curvature, geometrical interpretation of curvature tensor, Ricci tensor, scalar curvature, Einstein space and Einstein tensor.	9

Suggested Readings (Part-A Differential Geometry):

1. T.J. Willmore, An Introduction to Differential Geometry, Dover Publications, 2012.
2. B. O'Neill, Elementary Differential Geometry, 2nd Ed., Academic Press, 2006.
3. C.E. Weatherburn, Differential Geometry of Three Dimensions, Cambridge University Press 2003.
4. D.J. Struik, Lectures on Classical Differential Geometry, Dover Publications, 1988.
5. S. Lang, Fundamentals of Differential Geometry, Springer, 1999.
6. B. Spain, Tensor Calculus: A Concise Course, Dover Publications, 2003.
7. An Introduction to Differential Geometry (with the use of tensor Calculus), L. P. Eisenhart, Princeton University Press, 1940.
8. Tensor Analysis, Theory and Applications to Geometry and Mechanics of Continua, 2nd Edition, I. S. Sokolnikoff, John Wiley and Sons., 1964.

9. Suggested digital plateform:NPTEL/SWAYAM/MOOCs, www.mooc-list.com/tags/mathe, http://heecontent.upsdc.gov.in/

10. Course Books published in Hindi may be prescribed by the Universities.

Suggested Readings (Part-B Tensor Analysis):

1. Tensors- Mathematics of Differential Geometry by Z. Ahsan, PHI,2015
2. David C. Kay, Tensor Analysis, Schaum's Outline Series, McGraw Hill 1988.
3. R. S, Mishra, A Course in Tensors with Applications to Reimannian Geometry, Pothishala Pvt. Ltd, Allahabad.
4. Suggested digital plateform:NPTEL/SWAYAM/MOOCS, www.mooc-list.com/tags/mathe, http://heecontent.upsdc.gov.in/
5. Course Books published in Hindi may be prescribed by the Universities.

This course can be opted as an elective by the students of following subjects: Engg. and Tech. (UG), B.Sc.(C.S.)

Suggested Continuous Evaluation Methods: Max. Marks: 25

SN	Assessment Type	Max. Marks
1	**Class Tests**	10
2	**Online Quizzes/ Objective Tests**	5
3	**Presentation**	5
4	**Assignment**	5

Course prerequisites: To study this course, a student must have Diploma in Mathematics

Suggested equivalent online courses: https://www.edx.org, https://www.coursera.org/courses, https://www.ugc.ac.in/, www.snuadmissions.com/bsc/mathematics.

Further Suggestions:

B.A./B.Sc. III (SEMESTER-VI) PAPER-I METRIC SPACES & COMPLEX ANALYSIS

Programme: Degree **Class: B.A./B.Sc.**	**Year: Third**	**Semester: Sixth**
Subject: Mathematics		
Course Code: B030601T	**Course Title: METRIC SPACES & COMPLEX ANALYSIS**	
Credits: 4	**Core Compulsory / Elective**	
Max. Marks: 25+75	**Min. Passing Marks:**	

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0

Part- A

Metric Spaces

Unit	Topics	No. of Lectures
I	**Basic Concepts** Metric spaces**:** Definition and examples, Sequences in metric spaces, Cauchy sequences, Complete metric space.	**8**
II	**Topology of Metric Spaces** Open and closed ball, Neighborhood, Open set, Interior of a set, limit point of a set, derived set, closed set, closure of a set, diameter of a set, Cantor's theorem, Subspaces, Dense set.	**8**
III	**Continuity & Uniform Continuity in Metric Spaces** Continuous mappings, Sequential criterion and other characterizations of continuity, Uniform continuity, Homeomorphism, Contraction mapping, Banach fixed point theorem.	**7**
IV	**Connectedness and Compactness** Connectedness, Connected subsets of , Connectedness and continuous mappings, Compactness, Compactness and boundedness, Continuous functions on compact spaces.	**7**

Part- B
Complex Analysis

Unit	Topics	No. of Lectures
V	**Analytic Functions and Cauchy-Riemann Equations** Functions of complex variable, Mappings; Mappings by the exponential function, Limits, Theorems on limits, Limits involving the point at infinity, Continuity, Derivatives, Differentiation formulae, Cauchy-Riemann equations, Sufficient conditions for differentiability; Analytic functions and their examples.	**8**
VI	**Elementary Functions and Integrals** Exponential function, Logarithmic function, Branches and derivatives of logarithms, Trigonometric function, Derivatives of functions, Definite integrals of functions, Contours, Contour integrals and its examples, Upper bounds for moduli of contour integrals.	**8**
VII	**Cauchy's Theorems and Fundamental Theorem of Algebra** Antiderivatives, Proof of antiderivative theorem, Cauchy-Goursat theorem, Cauchy integral formula; An extension of Cauchy integral formula, Consequences of Cauchy integral formula, Liouville's theorem and the fundamental theorem of algebra.	**7**
VIII	**Series and Residues** Convergence of sequences and series, Taylor series and its examples; Laurent series and its examples, Absolute and uniform convergence of power series, Uniqueness of series representations of power series, Isolated singular points, Residues, Cauchy's residue theorem, residue at infinity; Types of isolated singular points, Residues at poles and itsexamples.	**7**

Suggested Readings (Part-A Metric Space):

1. Mathematical Analysis by Shanti Narain.
2. Shirali, Satish & Vasudeva, H. L. (2009). Metric Spaces, Springer, First Indian Print.
3. Kumaresan, S. (2014). Topology of Metric Spaces (2nd ed.). Narosa Publishing House. New Delhi.
4. Simmons, G. F. (2004). Introduction to Topology and Modern Analysis.Tata McGraw Hill. New Delhi.
5. Suggested digital plateform:NPTEL/SWAYAM/MOOCS, www.mooc-list.com/tags/mathe, http://heecontent.upsdc.gov.in/
6. Course Books published in Hindi may be prescribed by the Universities.

Suggested Readings (Part-B Complex Analysis):

1. Function of Complex Variable by Shanti Narain.
2. Complex variable and applications by Brown & Churchill.
3. Suggested digital plateform:NPTEL/SWAYAM/MOOCS, www.mooc-list.com/tags/mathe, http://heecontent.upsdc.gov.in/
4. Course Books published in Hindi may be prescribed by the Universities.

This course can be opted as an elective by the students of following subjects: Engg. and Tech. (UG), B.Sc.(C.S.)

Suggested Continuous Evaluation Methods: Max. Marks: 25

SN	Assessment Type	Max. Marks
1	**Class Tests**	**10**
2	**Online Quizzes/ Objective Tests**	**5**
3	**Presentation**	**5**
4	**Assignment**	**5**

Course prerequisites: To study this course, a student must have Diploma in Mathematics

Suggested equivalent online courses: https://www.edx.org, https://www.coursera.org/courses, https://www.ugc.ac.in/, www.snuadmissions.com/bsc/mathematics.

Further Suggestions:

B.A./B.Sc. III (SEMESTER-VI) PAPER-II Numerical Analysis & Operation Research

Programme: Degree **Class: B.A./B.Sc.**	**Year: Third**	**Semester: Sixth**
Subject: Mathematics		
Course Code: B030602T	**Course Title: Numerical Analysis & Operations Research**	
Credits: 4	**Core Compulsory / Elective**	
Max. Marks: 25+75	**Min. Passing Marks:**	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0		

PART-A

Numerical Analysis

Unit	Topics	No. of Lectures
I	Solution of equations: bisection, Secant, Regular Falsi, Newton Raphson's method, Newton's method for multiple roots, Interpolation, Lagrange and Hermite interpolation, Difference schemes, Divided differences, Interpolation formula using differences.	**8**
II	Numerical differentiation, Numerical Quadrature: Newton Cotes Formulas, Gaussian Quadrature Formulas, System of Linear equations: Direct method for solving systems of linear equations (Gauss elimination, LU Decomposition, Cholesky Decomposition), Iterative methods (Jacobi, Gauss Seidel, Relaxation methods). The Algebraic Eigen value problem: Jacobi's method, Givens method, Power method.	**8**
III	Numerical solution of Ordinary differential equations: Euler method, single step methods, Runge-Kutta method, Multi-step methods: Milne-Simpson method, Types of approximation: Last Square polynomial approximation, Uniform approximation, Chebyshev polynomial approximation.	**7**
IV	Difference Equations and their solutions, Shooting method and Difference equation method for solving Linear second order differential equation with boundary conditions of first, second and third type.	**7**

PART-B

Operations Research

Unit	Topics	No. of Lectures
V	Introduction, Linear programming problems, statement and formation of general linear programming problems, graphical method, slack and surplus variables, standard and matrix forms of linear programming problem, basic feasible solution.	**8**
VI	Convex sets, fundamental theorem of linear programming, basic solution, Simplex method, introduction to artificial variables, two phase method Big-M method and their comparison.	**8**
VII	Resolution of degeneracy, duality in linear programming problems, primal dual relationships, revised simplex method, sensitivity analysis.	**7**
VIII	Transportation problems, assignment problems.	**7**

Suggested Readings(Part-A Numerical Analysis):

1. Numerical Methods for Engineering and scientific computation by M. K. Jain, S.R.K. Iyengar & R.K. Jain.
2. Introductory methods of Numerical Analysis by S. S. Sastry
3. Suggested digital plateform:NPTEL/SWAYAM/MOOCs, www.mooc-list.com/tags/mathe, http://heecontent.upsdc.gov.in/
4. Course Books published in Hindi may be prescribed by the Universities.

Suggested Readings(Part-B Operation Research):

1. Taha, Hamdy H, "Opearations Research- An Introduction ", Pearson Education.
2. Kanti Swarup , P. K. Gupta , Man Mohan Operations research, Sultan Chand & Sons
3. Hillier Frederick S and Lieberman Gerald J., “Operations Research”, McGraw Hill Publication.
4. Winston Wayne L., “Operations Research: Applications and Algorithms”, Cengage Learning, 4th Edition.
5. Hira D.S. and Gupta Prem Kumar, “Problems in Operations Research: Principles and Solutions”, S Chand & Co Ltd.
6. Kalavathy S., “Operations Research”, S Chand.
7. Suggested digital plateform:NPTEL/SWAYAM/MOOCs, www.mooc-list.com/tags/mathe, http://heecontent.upsdc.gov.in/
8. Course Books published in Hindi may be prescribed by the Universities.

This course can be opted as an elective by the students of following subjects: Engg. and Tech. (UG), Economics(UG/PG), B.Sc.(C.S.)

Suggested Continuous Evaluation Methods: Max. Marks: 25

SN	Assessment Type	Max. Marks
1	**Class Tests**	**10**
2	**Online Quizzes/ Objective Tests**	**5**
3	**Presentation**	**5**
4	**Assignment**	**5**

Course prerequisites: To study this course, a student must have Certificate Course in Applied Mathematics

Suggested equivalent online courses: https://www.edx.org, https://www.coursera.org/courses, https://www.ugc.ac.in/, www.snuadmissions.com/bsc/mathematics.

Further Suggestions:

B.A./B.Sc. III (SEMESTER-VI) PAPER-III Practical

Programme: Degree **Class: B.A./B.Sc.**	**Year: Third**	**Semester: Sixth**
Subject: Mathematics		
Course Code: B030603P	**Course Title: Practical**	
Credits: 2	**Core Compulsory / Elective**	
Max. Marks: 25+75	**Min. Passing Marks:**	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 0-0-4		

Unit	Topics	No. of Lectures
	Practical / Lab work to be performed in Computer Lab. List of the practicals to be done using computer algebra software (CAS), for example Mathematica/MATLAB/Maple/ Maxima/Scilab etc 1. Solution of transcendental and algebraic equations by i) Bisection method ii) Newton Raphson method (Simple root, multiple roots, complex roots). iii) Secant method. iv) Regula Falsi method. 2. Solution of system of linear equations i) LU decomposition method ii) Gaussian elimination method iii) Gauss-Jacobi method iv) Gauss-Seidel method 3. Interpolation i) Lagrange Interpolation ii) Newton's forward, backward and divided difference interpolations 4. Numerical Integration i) Trapezoidal Rule ii) Simpson's one third rule iii) Weddle's Rule iv) Gauss Quadrature 5. Method of finding Eigenvalue by Power method (up to 4×4) 6. Fitting a Polynomial Function (up to third degree)	

	7. Solution of ordinary differential equations i) Euler method ii) Modified Euler method iii) Runge Kutta method (order 4) (iv) The method of successive approximations (Picard)	

Suggested Readings:

This course can be opted as an elective by the students of following subjects: Engg. and Tech. (UG), Economics(UG/PG), B.Sc.(C.S.)

Suggested Continuous Evaluation Methods: Max. Marks: 25

SN	Assessment Type	Max. Marks
1	**Class Tests**	**10**
2	**Online Quizzes/ Objective Tests**	**5**
3	**Presentation**	**5**
4	**Assignment**	**5**

Course prerequisites: To study this course, a student must have Certificate Course in Applied Mathematics

Suggested equivalent online courses: https://www.edx.org, https://www.coursera.org/courses, https://www.ugc.ac.in/, www.snuadmissions.com/bsc/mathematics.

Further Suggestions: