Date:- 01-07-2025

To,
The Dean Academics
Chhatrapati Shahu Ji Maharaj University Kanpur

Subject:-Report of online meeting conducted by the Board of Studies-Mathematics, CSJMU Sir,
Following the guidelines received from the U.P. government regarding four years B.Sc. (Honours) Course in Mathematics, B.Sc. (Honours with Research) Course in Mathematics, and the integrated post graduate course, the Board of Studies-Mathematics conducted an online meeting (Google-meet), with video conferencing at the CSJM University Campus, Kanpur on 1st July, 2025 at 12:00 PM. The course structure and syllabus for four years B.Sc. (Honours) Course in Mathematics, B.Sc. (Honours with research) course in Mathematics and integrated post graduate course in Mathematics, was passed and approved by the BOS unanimously after some discussion and minor changes. The following members of the BOS and some special invited members joined the meeting:-

Convener
Prof. Pushpendra Kumar Tripathi, DAV College, Kanpur

External Members
1. Prof. A. K. Mishra, BHU Varanasi
2. Prof. Sahadeo Padhye, MNNIT Prayagraj
3. Prof. Shalabh, IIT Kanpur
4. Prof. Pankaj Mathur, Lucknow University, Lucknow
5. Prof. Rekha Bali, HBTU, Kanpur
6. Prof. Ujjwal Sen, Director HRI, Prayagraj

Internal Members
1. Prof. Arvind Kumar Sharma, Principal, Janta Mahavidyalaya Ajitmal
2. Prof. Ravindra Kumar Juneja, Christ Church College, Kanpur
3. Prof. Manoj Kumar Gupta, K.K. (P.G.) College, Etawah

Invited Members
1. Prof. Mukesh Kumar Singh, Principal, Armapur Degree College, Kanpur
2. Prof. Abhishek Kumar, DAV College Kanpur
3. Prof. A. L. Pathak, BND College, Kanpur
4. Prof. S. N. Mishra, BND College, Kanpur
5. Prof. Parijat Sinha, VSSD College, Kanpur
6. Dr. Maninder Singh Arora, PPN College, Kanpur

7. Dr. Namita Tiwari, CSJM University Campus, Kanpur
8. Dr. P. N. Pathak, CSJM University Campus, Kanpur
9. Dr. Arpit Dwivedi, CSJM University Campus, Kanpur
10. Dr. Ajeet Kumar, VSSD College, Kanpur
11. Dr. Ashish Kumar Shukla, DBS College, Kanpur
12. Dr. Sanjeev Kumar Singh, VSSD College, Kanpur
13. Dr. Subal Chandra Ghosh, DAV College Kanpur

(Prof. Pushpendra Kumar Tripathi)
Convenor, BOS-Mathematics

CONVENER
MATHEMATICS
C.S.J.M. UNIVERSITY, KANPUR

(Prof. A. K. Misra) (Prof. Sahadeo Padhye) (Prof. Shalabh) (Prof. Pankaj Mathur) (Prof. Rekha Bali)

(Prof. A. K. Sharma) (Prof. R. K. Juneja) (Prof. M. K. Gupta) (Prof. Mukesh Kumar Singh) (Prof. Abhishek Kumar)

(Prof. A. L. Pathak) (Prof. S. N. Mishra) (Prof. Parijat Sinha) (Dr. Maninder Singh Arora) (Dr. Namita Tiwari)

(Dr. P. N. Pathak) (Dr. Arpit Dwivedi) (Dr. Ajeet Kumar) (Dr. Ashish Kumar Shukla) (Dr. Sanjeev Kumar Singh)

(Dr. Subal Chandra Ghosh)

Minutes of the Meeting of Board of Studies (held on 01 July 2025)

A Meeting of the Board of Studies (BOS) for the subject-Mathematics was held on 01st July, 2025 at 12:00 PM via online mode (Google-meet), with video conferencing at the CSJM University Campus, Kanpur. The agenda was to discuss and approve the course structure and syllabus of the B.Sc. (Honours) in Mathematics, B.Sc. (Honours with research) in Mathematics and M.Sc. Mathematics programs.

The detailed course structure and syllabus for both programs had already been shared with all BOS members. These programs have been designed in accordance with the Curricular & Credit Framework for the Four Year Undergraduate Programme (FYUP). During the meeting, a presentation on the course structure and syllabus was delivered. After thorough discussion on each aspect of the syllabus, the following suggestions and recommendations were made by the BOS members:

1. The suggestion to change the title Advanced Real Analysis as Measure Theory has been incorporated.

2. The suggestion to change the title Advanced Ordinary Differential Equations as Ordinary Differential Equations and Stability Analysis has been incorporated.

3. All other minor recommendations were incorporated into the syllabus as advised by the Board members. The members unanimously approved the final syllabus.

The Meeting was attended by the Following BOS Members:

Convener
Prof. Pushpendra Kumar Tripathi, DAV College, Kanpur

External Members

1. Prof. A. K. Mishra, BHU Varanasi
2. Prof. Sahadeo Padhye, MNNIT Prayagraj
3. Prof. Shalabh, IIT Kanpur
4. Prof. Pankaj Mathur, Lucknow University, Lucknow
5. Prof. Rekha Bali, HBTU, Kanpur
6. Prof. Ujjwal Sen, Director HRI, Prayagraj

Internal Members

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Invited Members

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5. Prof. Parijat Sinha, VSSD College, Kanpur
6. Dr. Maninder Singh Arora, PPN College, Kanpur
7. Dr. Namita Tiwari, CSJM University Campus, Kanpur
8. Dr. P. N. Pathak, CSJM University Campus, Kanpur
9. Dr. Arpit Dwivedi, CSJM University Campus, Kanpur
10. Dr. Ashish Kumar Shukla, DBS College, Kanpur
11. Dr. Ajeet Kumar, VSSD College, Kanpur
12. Dr. Sanjeev Kumar Singh, VSSD College, Kanpur
13. Dr. Subal Chandra Ghosh, DAV College Kanpur

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 CODE**	**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 Equations & Mechanics	THEORY	**6**
		B030402R	Research Project	PROJECT	**3**
DEGREE IN MATHEMATICS					
THIRD YEAR	**V**	B030501T	Group and Ring Theory & Linear Algebra	THEORY	**5**
		B030502T B030503T B030504T	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 Spaces & Complex Analysis	THEORY	**4**
		B030602T	Numerical Analysis & Operations Research	THEORY	**4**
		B030603P	Practical	PRACTICAL	**2**
DEGREE (HONOURS) IN MATHEMATICS					
FOURTH YEAR	**VII**	B030701TN	Real Analysis	THEORY (CORE)	**4**
		B030702TN	Topology	THEORY (CORE)	**4**
		B030703TN	Advanced Complex Analysis	THEORY (CORE)	**4**
		B030704TN	Dynamics of Rigid Bodies	THEORY (CORE)	**4**
		B030705PN	Computational Mathematics with Python-I	PRACTICAL	**4**
	VIII	B030801TN	Measure Theory	THEORY (CORE)	**4**
		B030802TN	Advanced Topology	THEORY (CORE)	**4**
		B030803TN	Operations Research	THEORY (CORE)	**4**
		B030804TN	Mathematical Statistics	THEORY (CORE)	**4**
		B030805PN	Computational Mathematics with Python-II	PRACTICAL	**4**

DEGREE (HONOURS WITH RESEARCH) IN MATHEMATICS					
FOURTH YEAR	**VII**	B030701TN	Real Analysis	THEORY (CORE)	**4**
		B030702TN	Topology	THEORY (CORE)	**4**
		B030703TN	Advanced Complex Analysis	THEORY (CORE)	**4**
		B030705PN	Computational Mathematics with Python-I	PRACTICAL	**4**
		B030706RN	Research Project	PROJECT	**4**
	VIII	B030801TN	Measure Theory	THEORY (CORE)	**4**
		B030802TN	Advanced Topology	THEORY (CORE)	**4**
		B030803TN	Operations Research	THEORY (CORE)	**4**
		B030805PN	Computational Mathematics with Python-II	PRACTICAL	**4**
		B030806RN	Research Project	PROJECT	**4**
PG DEGREE IN MATHEMATICS (1 YEAR)					
FIFTH YEAR	**IX**	B030901TN	Abstract Algebra	THEORY (CORE)	**4**
		B030902TN	Functional Analysis	THEORY (CORE)	**4**
		B030903TN	Fluid Dynamics	THEORY (CORE)	**4**
		B030904TN B030905TN B030906TN B030907TN B030908TN B030909TN B030910TN	(I) Special Functions (II) Ordinary Differential Equations and Stability Analysis (III) History and Development of Indian Mathematics (IV) Bio-Mechanics (V) Fuzzy Set Theory (VI) Programming in C	THEORY (ELECTIVE) (ANYONE)	**4**
		B030911RN	Research Project/Dissertation	PROJECT	**4**
FIFTH YEAR	**X**	B031001TN	Advanced Abstract Algebra	THEORY (CORE)	**4**
		B031002TN	Integral Equations and Boundary Value Problems	THEORY (CORE)	**4**
		B031003TN B031004TN B031005TN B031006TN B031007TN	(I) Advanced Fluid Mechanics (II) Wavelet Analysis (III) Special Theory of Relativity (IV) Differential Geometry of Manifolds (V) Advanced Discrete Mathematics	THEORY (ELECTIVE) (ANYONE)	**4**
		B031008TN B031009TN B031010TN B031011TN B031012TN	(I) Operator Theory (II) Calculus of Variations (III) Mathematical Modelling (IV) Cosmology (V) Cryptography	THEORY (ELECTIVE) (ANYONE)	**4**
		B031013RN	Research Project/Dissertation	PROJECT	**4**

PROPOSED STRUCTURE OF UG MATHEMATICS SYLLABUS AS PER NEP 2020 GUIDELINES

GENERAL OVERVIEW

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.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 Equations & Mechanics** **Part A: Differential Equations** **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)
			Paper-2	3	3	3x15=45	**Research Project**		Certificate Course in Applied Mathematics	

Note: In semester IV, the student will need to submit a research project on any topic from the syllabus of the first four semesters.

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)	Diploma in 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.)

Shalaksh

B.Sc. IV

PROGRAMME	YEAR	SEMESTER (15 Weeks)	PAPER	CREDIT	PERIODS Per Week	PERIODS (HOURS)	PAPER TITLE	UNIT (Periods Per Semester)	PREREQUISITE	ELECTIVE (For Other Faculty)
DEGREE (HONOURS) COURSE IN MATHEMATICS	FOURTH YEAR	SEMESTER – VII	**Paper-1**	4	4	4x 15= 60	**Real Analysis**	Unit I (14) Unit II (16) Unit III (17) Unit IV (13)	Degree in Mathematics	
			Paper-2	4	4	4x 15= 60	**Topology**	Unit I (14) Unit II (17) Unit III (17) Unit IV (12)	Degree in Mathematics	
			Paper-3	4	4	4x 15= 60	**Advanced Complex Analysis**	Unit I (13) Unit II (16) Unit III (16) Unit IV (15)	Degree in Mathematics	
			Paper-4	4	4	4x 15= 60	**Dynamics of Rigid Bodies**	Unit I (12) Unit II (16) Unit III (17) Unit IV (15)	Degree in Mathematics	
			Paper-5	4	4	4x 15= 60	**Computational Mathematics with Python-I**			

			Paper-6	4	4	4x 15= 60	**Research Project**		
		SEMESTER – VIII	**Paper-1**	4	4	4x 15= 60	**Measure Theory**	Unit I (14) Unit II (16) Unit III (17) Unit IV (13)	Degree in Mathematics
			Paper-2	4	4	4x 15= 60	**Advanced Topology**	Unit I (14) Unit II (17) Unit III (17) Unit IV (12)	Degree in Mathematics
			Paper-3	4	4	4x 15= 60	**Operations Research**	Unit I (13) Unit II (16) Unit III (16) Unit IV (15)	Degree in Mathematics
			Paper-4	4	4	4x 15= 60	**Mathematical Statistics**	Unit I (12) Unit II (16) Unit III (17) Unit IV (15)	Degree in Mathematics

			Paper-5	4	4	4x 15= 60	**Computational Mathematics with Python-II**			
			Paper-6	4	4	4x 15= 60	**Research Project**			

Note: For B.Sc. Hons degree, students opt four core papers and a practical, whereas for B.Sc. Hons degree with research students opt first three core papers, practical and research project during seventh and eighth semester each.

PG DEGREE (1 YEAR)

PROGRAMME	YEAR	SEMESTER (15 Weeks)	PAPER	CREDIT	PERIODS Per Week	PERIODS (HOURS)	PAPER TITLE	UNIT (Periods Per Semester)	PREREQUISITE	ELECTIVE (For Other Faculty)
INTEGRATED PG DEGREE IN MATHEMATICS	FIFTH YEAR	SEMESTER – IX	Paper-1	4	4	4x 15= 60	**Abstract Algebra**	Unit I (15) Unit II (17) Unit III (16) Unit IV (12)	Degree (Honours) with research	
			Paper-2	4	4	4x 15= 60	**Functional Analysis**	Unit I (14) Unit II (16) Unit III (17) Unit IV (13)	Degree (Honours) with research	
			Paper-3	4	4	4x 15= 60	**Fluid Dynamics**	Unit I (13) Unit II (17) Unit III (17) Unit IV (13)	Degree (Honours) with research	
			Paper-4	4	4	4x 15= 60	**(I) Special Functions** **(II) Ordinary Differential Equations and Stability Analysis** **(III) History and Development of Indian Mathematics** **(IV) Bio-Mechanics** **(V) Fuzzy Set Theory** **(VI) Programming in C** **(VII) Vedic Ganita**	Unit I (12) Unit II (16) Unit III (16) Unit IV (16)	Degree (Honours) with research	
			Paper-5	4	4	4x 15= 60	**Research Project**		Degree (Honours) with research	

		SEMESTER – X	**Paper-1**	4	4	4x 15= 60	**Advanced Abstract Algebra**	Unit I (14) Unit II (16) Unit III (17) Unit IV (13)	Degree (Honours) with research	
			Paper-2	4	4	4x 15= 60	**Integral Equations and Boundary Value**	Unit I (14) Unit II (17) Unit III (17) Unit IV (12)	Degree (Honours) with research	
			Paper-3	4	4	4x 15= 60	**(I) Advance Fluid Mechanics** **(II) Wavelet Analysis** **(III) Special Theory of Relativity** **(IV) Differential Geometry of Manifolds** **(V) Advanced Discrete Mathematics**	Unit I (13) Unit II (16) Unit III (16) Unit IV (15)	Degree (Honours) with research	
			Paper-4	4	4	4x 15= 60	**I) Operator Theory** **(II) Calculus of Variations** **(III) Mathematical Modelling** **(IV) Cosmology** **(V) Cryptography**	Unit I (12) Unit II (16) Unit III (17) Unit IV (15)	Degree (Honours) with research	
			Paper-5	4	4	4x 15= 60	**Research Project**		Degree (Honours) with research	

B.Sc. I (MATHEMATICS)

Detailed Syllabus For

CERTIFICATE COURSE

IN

APPLIED MATHEMATICS

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

Programme: Certificate **Class: 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	Limit, continuity and differentiability of function of single variable, Cauchy's definition, Heine's definition, equivalence of definition of Cauchy and Heine, Indeterminate form, point set theory of real numbers.	**9**
II	Definition of a sequence, theorems on limits of sequences, bounded and monotonic sequences, Cauchy sequence, Convergent sequence subsequence, Series of non-negative terms, convergence and divergence, Comparison tests, alternating series, Leibnitz's test, Cauchy's integral test, Ratio tests, Root test, Raabe's, logarithmic test, de Morgan and second logarithmic tests, absolute and conditional convergence.	**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, Total differentiation, change of variables.	**7**
IV	Tangent and normals, Asymptotes, Curvature, Envelops and evolutes, Tests for concavity and convexity, Points of inflexion, Multiple points, Tracing of curves in Cartesian, Polar forms and parametric curves.	**7**

Part-B
Integral Calculus

Unit	Topics	No. of Lectures
V	Definite integrals, Rectification, Quadrature, Volumes and Surfaces of Solid of revolution, Pappus theorem, Beta and Gamma functions, 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.	7
VII	Multiple integrals, change of order of double integration, Change of variables, 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.
8. Dr. Parijat Sinha, A Text Book of Differential Calculus, Kedar Nath Ram Nath.

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/

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.Sc. I (SEMESTER-I) Paper-II Practical

Programme: Certificate **Class: 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 the plot. (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.Sc. I (SEMESTER-II) PAPER-I Matrices and Differential Equations & Geometry

Programme: Certificate **Class: 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, Inverse of a Matrix by elementary operations, Rank of a Matrix, Echelon form of a Matrix, Normal form of a Matrix, 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, Cayley-Hamilton theorem and its use in finding inverse of a matrix.	**11**
III	Formation of ordinary differential equations, Geometrical meaning of a differential equation, solutions of ODEs of first order and first degree (variables are separable, Homogeneous equations, Linear equations, Exact differential equations and equations reducible to the exact form).	**11**
IV	First order higher degree equations solvable for x, y, p, Clairaut's equation and singular solutions, orthogonal trajectories, Linear differential equation with constant coefficients, Cauchy- Euler form, homogeneous linear differential equations.	**11**

PART-B

Geometry

Unit	Topics	No. of Lectures
V	General equation of second degree, Polar equation of conics and its properties.	12
VI	Three-Dimensional Coordinates, Projection and Direction Cosine, Plane, Straight line in three dimensions.	11
VII	Sphere, Cone and Cylinder.	11
VIII	Central 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 platform: 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 platform: 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.Sc. II (MATHEMATICS)

Detailed Syllabus For

DIPLOMA

IN

MATHEMATICS

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

Programme: Diploma **Class: 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 transforms (finite and infinite), Fourier integral, Applications of Fourier transforms.	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 platform: 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 platform: 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.Sc. II (SEMESTER-IV) PAPER-I Differential Equations & Mechanics

Programme: Diploma **Class: 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, variation of parameters, Series solutions of differential equations, Power series method.	**12**
II	Bessel and Legendre 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.	**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.	**11**

Part- B

Mechanics

Unit	Topics	No. of Lectures
V	Forces in three dimensions, Poinsot's central axis, Wrenches, Null lines and planes.	12
VI	Virtual work, Stable and Unstable equilibrium, Catenary, approximation of Catenary.	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	Central orbit, Kepler's laws of motion, Motion of particle in three dimensions, Rotating frame of reference.	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 platform: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 platform: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.Sc. III (MATHEMATICS)

Detailed Syllabus For

DEGREE

IN

MATHEMATICS

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

Programme: Degree **Class: 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.	**10**
II	Conjugacy classes, The class equation, *p*-groups, The Sylow theorems and consequences, Applications of Sylow theorems; Finite simple groups, Nonsimplicity tests, Index theorem.	**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 Hamilton Theorem.	**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 platform: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.Sc. III (SEMESTER-V) PAPER-II (i) Number Theory & Game Theory

Programme: Degree **Class: 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 Recurrance 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	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 platform: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 platform: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.Sc. III (SEMESTER-V) PAPER-II (ii) Graph Theory & Discrete Mathematics

Programme: Degree **Class: B.Sc.**	**Year: Third**	**Semester: Sixth**
Subject: Mathematics		
Course Code: B030503T	**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 truth table.	10
VI	**Relation**- Definition, types of relation, domain and range of a relation, pictorial representation of relation, properties of relation, partial ordering relation. **Boolean Algebra-** Basic definitions, Sum of products and products of sums, Logic gates and Karnaugh maps.	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, Deterministic 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 platform: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 platform: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.Sc. III (SEMESTER-V) PAPER-II (iii) Differential Geometry & Tensor Analysis

Programme: Degree **Class: B.Sc.**	**Year: Third**	**Semester: Sixth**
Subject: Mathematics		
Course Code: B030503T	**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.	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's theorem.	9

Part- B
Tensor Analysis

Unit	Topics	No. of Lectures
V	Tensor Analysis: Contravariant and covariant vectors and tensors, Mixed tensors, Symmetric and skew-symmetric tensors,	10
VI	Algebra of tensors, Contraction and inner product, tensor product of vector spaces, Quotient theorem, Reciprocal tensors, Christoffel's symbols, Law of transformation of Christoffel's symbols, Covariant differentiation, non- commutativity of Covariant derivative.	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 platform: 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 platform: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.Sc. III (SEMESTER-VI) PAPER-I METRIC SPACES & COMPLEX ANALYSIS

Programme: Degree **Class: 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** Riemann integral, 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, Subspaces, Dense and non-dense sets, Categories.	**8**
II	**Metric Spaces** Metric spaces**:** Definition and examples, Sequences in metric spaces, Cauchy sequences, Complete metric space, Baire's Category theorem, Cantor's intersection theorem.	**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, continuous mappings on connected sets, 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, Limits, Continuity, Derivatives, Differentiation formulae, Analytic functions and their examples, Cauchy-Riemann equations (Cartesian and Polar form), Sufficient conditions for analyticity, Derivatives of analytic functions, Construction of analytic functions.	**8**
VI	**Elementary Functions and Integrals** Exponential function, Logarithmic function, Branches and derivatives of logarithms, Trigonometric function, Definite integrals of functions, Contours, Contour integrals and its examples, Upper bounds for moduli of contour integrals.	**8**
VII	**Cauchy's Theorems** Cauchy Theorem, Cauchy-Goursat theorem (Only statement), Cauchy integral formula, An extension of Cauchy integral formula, Consequences of Cauchy integral formula, Liouville's theorem, Morera's Theorem.	**7**
VIII	**Power Series and Residues** Power series, Convergence of Power series, Radius of convergence, Taylor series and its examples; Laurent series and its examples, Uniqueness of series representations of power series, Singularities and their classifications, Residues, Cauchy's residue theorem, residue at infinity.	**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 platform: 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 platform: 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.Sc. III (SEMESTER-VI) PAPER-II Numerical Analysis & Operation Research

Programme: Degree **Class: 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	Finite differences, forward, backward, divided differences, fundamental theorem of finite differences, Interpolation formula with equal interval, Solution of equations: bisection, Secant, Regular Falsi, Newton Raphson's method, Newton's method for multiple roots.	**8**
II	Interpolation formula with equal interval Numerical differentiation, Numerical integration, General Quadrature Formula, Trapezoidal rule, Simpson's 1/3 and 3/8 rule, Weddle rule.	**8**
III	System of Linear equations: Direct method for solving systems of linear equations (Gauss elimination, LU Decomposition), Iterative methods (Jacobi, Gauss Seidel). Numerical solution of Ordinary differential equations: Euler method, Euler's modified method, Picard's method, Milne-Thomson's method, Runge-Kutta method.	**7**
IV	Difference Equations and their solutions, Types of approximation: Least Square polynomial approximation, Uniform approximation, Chebyshev polynomial approximation, The Algebraic Eigen value problem: Jacobi's method, Givens method, Power method.	**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, solutions of LPP.	**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.	**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 platform: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 platform: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.Sc. III (SEMESTER-VI) PAPER-III Practical

Programme: Degree Class: /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 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:

Shalabh

B.Sc. IV (MATHEMATICS)

Detailed Syllabus For

DEGREE
(HONOURS)

IN
MATHEMATICS

Note: For B.Sc. Hons degree, students opt four core papers and a practical, whereas for B.Sc. Hons degree with research students opt first three core papers, practical and research project during seventh and eighth semester each.

B.Sc. IV (SEMESTER-VII) PAPER-I Real Analysis

Programme: Degree Honours **Class: B.Sc.**	**Year: Fourth**	**Semester: Seventh**
Subject: Mathematics		
Course Code: B030701TN	**Course Title: Real 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	

Real Analysis

Unit	Topics	No. of Lectures
I	Definition and existence of Riemann-Stieltjes integral, Properties of integral, Riemann Stieltjes integral as a limit of sums, Mean value theorem for RS-integrals, Integration and differentiation, Fundamental theorem of integral calculus.	14
II	Uniform convergence of sequence and series of functions, -test, Weierstrass M-test, Abel test, Dirichlet test, Uniform convergence and continuity, Uniform convergence and integration, Uniform convergence and differentiation, Weirerstrass approximation theorem.	16
III	Power series, Radius of convergence, Uniform convergence of power series, Uniqueness theorem for power series, Abel Theorem, Tauber's Theorem, Functions of bounded variation, Algebra of functions of bounded variation, Jordan-decomposition theorem.	17
IV	Concept of functions of several variables, Euclidean′s spaces, Linear transformations, Limit of function, Continuous function, Derivatives in an open subset of, Chain rule, Partial derivatives, Directional Derivatives, Repeated partial derivatives, Mean value theorem for vector valued functions, Taylor′s Theorem, Inverse function theorem, Implicit function theorem	13
	Suggested Readings: **1.** G.F. Simmons, Topology and Modern Analysis, McGraw-Hill Book company. **2.** T.M. Apostol, Mathematical Analysis, Narosa Publishing House. **3.** B.B.Dutta and A.N singh, History of Hindu Mathematics, 2-Vol. Bharatiya Kala Prakashan, Delhi -2001 4. C.N,Srinivasiengar, The History of Ancient Indian Mathematics, World Press, 1988 5. W. Rudin, Principles of Mathematical Analysis, McGraw-Hill Book company. 6. Parijat Sinha, Real Analysis, Kedarnath Ramnath Publications.	

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:

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

B.Sc. IV (SEMESTER-VII) PAPER-II Topology

Programme: Degree Honours Class: B.Sc.	Year: Fourth	Semester: Seventh
Subject: Mathematics		
Course Code: B030702TN	Course Title: Topology	

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

Topology

Unit	Topics	No. of Lectures
I	Topological space: Definition through open set axioms, Examples include usual topology, Ray, Lower limit and upper limit topologies on R, Co-finite and co-countable topologies, Weak and strong topologies, The topology of metric spaces, Equivalent metrics, Metrizable spaces, Intersection and union of topologies, Closed sets, Limit points, Derived sets, Adherent points, Dense set, Nowhere dense sets, Perfect sets, Characterization of closed sets in terms of derived sets, The interior of a set, Closure, Exterior, Boundary of a set.	14
II	Characterization of topologies in terms of closed sets, Kuratowski's closure axioms and characterization of topology in terms of these. Neighbourhoods, Neighbourhood system and neighbourhood base, Topology through neighbourhood axioms, Interior operator, Exterior operator, Characterization of topological spaces in terms of these, Base and subbase for topology and characterization of topology in terms of base and subbase axioms, Topology generated by a family of subsets.	17
III	First countable and second countable spaces, Relative topology and subspaces, Hereditary property, Lindeloff theorem and separable spaces, Continuous functions and their properties, Continuity in terms of open sets, closed sets, neighbourhoods and closures, Convergence of a sequence, Sequential continuity, Open mapping, Homeomorphisms, Topological invariant properties.	17
IV	Separation axioms- To, T1, T2, Regular, T3, Normal and T4 spaces, Their comparison and examples, Hereditary and Topological invariant characteristics, Completely regular space, Tychonoff space, Completely normal spaces, Urysohn's lemma and Tietze extension theorem.	12
	Suggested Readings: **1.** George F. Simmons, Introduction to Topology and Modern Analysis, Mc Graw-Hill Book Company (1963). **2.** J. L. Kelley, General Topology, Van Nostrand, Reinhold Co., New York (1995). **3**. K. D. Joshi, Introduction to General Topology, Wiley Eastern Ltd. (1983). **4**. James R. Munkres, Topology, Prentice Hall of India Pvt. Ltd., New Delhi (2000). **5**. S. Willard, General Topology Addison-Wesley, Reading, 1970. **6.** J. Dugundji, Topology, Allyn and Bacon, 1966 (Reprinted in India by PHI).	

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:

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

B.Sc. IV (SEMESTER-VII) PAPER-III Advanced Complex Analysis

Programme: Degree Honours Class: B.Sc.	Year: Fourth	Semester: Seventh
Subject: Mathematics		
Course Code: B030703TN	Course Title: Advanced 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

Advanced Complex Analysis

Unit	Topics	No. of Lectures
I	Stereographic projection, Branch point, Branch cut, Branches of multi-valued functions with special reference to $\arg z$, $\log z$ and z^a, Cauchy's inequality, Maximum and minimum modulus principle, Schwarz's lemma, Meromorphic functions.	13
II	Zeros of analytic functions, Singularities and their classification, Residues, Argument principle, Rouche′s theorem, Fundamental theorem of Algebra, Evaluation of real integrals, Linear and bilinear transformations, Fixed points, Cross ratio, Inverse points and critical points, Conformal transformations involving straight lines, Circles and half-planes.	16
III	Gamma function and its properties, Riemann zeta function, Mittag-Leffler's theorem, Analytic continuation, Uniqueness of analytic continuation along a curve, Power series method of analytic continuation, Natural boundary, Schwarz's reflection principle.	16
IV	Harmonic functions on a disk, Harnack′s inequality and theorem, Canonical products, Jensen′s formula, Hadamard′s three circle theorem, Entire functions, Order of an entire function, Exponent of convergence	15
	Suggested Readings: **1.** Complex Variables with an Introduction to Conformal Mapping and its Applications, Schaum's Outlines, McGraw-Hill, 2009. **2.** John B. Convey, Functions of One Complex Variable, Springer. **3.** Walter Rudin, Real and Complex Analysis, McGraw-Hill Co., 1966. **4.** H. S. Kasana, Complex Variables: Theory and Applications, PHI Learning. **5.** S. Ponnusamy, Foundations of Complex Analysis, Narosa Pub. **6.** R. V. Churchill & J. W. Brown, Complex Variables and Applications, 5th Edition, McGraw-Hill, New York, 1990. **7.** Shanti Narayan, Theory of Functions of a Complex Variable, S. Chand & Co., New Delhi.	

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:

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

B.Sc. IV (SEMESTER-VII) PAPER-IV Dynamics of Rigid Bodies

Programme: Degree Honours **Class: B.Sc.**	**Year: Fourth**	**Semester: Seventh**
Subject: Mathematics		
Course Code: B030704TN	**Course Title: Dynamics of Rigid Bodies**	

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	

Dynamics of Rigid Bodies

Unit	Topics	No. of Lectures
I	Moments and product of inertia with examples, Radius of Gyration, Momental ellipsoid, Principal axes, Equimomental system.	**12**
II	D'Alembert's principle, General equation of motion, Application of D'Alembert's principle to general equation of motion, Motion about fixed axis, Compound pendulum, Center of percussion.	**16**
III	Generalised coordinates, Degrees of freedom, Classification of mechanical systems, Generalized kinetic energy, Lagrangian equations by D'Alembert's principle, Lagrangian function, Principle of conservation of energy.	**17**
IV	Hamilton's principle, Hamilton's equation of motion and Hamiltonian function, Physical significance of the Hamiltonian, Derivation of Lagrange's equation by Hamilton's principle, Principle of least action, Deduction of Lagrange's equations using Hamilton's principle.	**15**
	Suggested Readings: **1.** Classical mechanics by J.C. Upadhyaya, Himalaya Publishing House Pvt. Ltd. **2.** Principles of Engineering Mechanics, Vol 2 by Millard F. Beatty, Jr, Springer International Edition. **3.** Classical mechanics by H. Goldstein, 2nd edition, Narosa Publishing House. **4.** Classical Mechanics by Gupta, Kumar and Sharma. **5.** Dynamics of Rigid Bodies by B.D. Sharma, B.S. Tyagi, Brahma Nand, Kedar Nath Ram Nath Publishers, India.	

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:

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

http://math.ucr.edu/home/baez/classical/texfiles/2005/book/classical.pdf

http://courses.physics.ucsd.edu/2010/Fall/physics200a/LECTURES/200_CO URSE.pdf

B.Sc. IV (SEMESTER-VII) PAPER-V Computational Mathematics with Python-I

Programme: Degree Honours **Class: B.Sc.**	**Year: Fourth**	**Semester: Seventh**
Subject: Mathematics		
Course Code: B030705PN	**Course Title: Computational Mathematics with Python-I**	

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

Computational Mathematics with Python-I

Unit	Topics	No. of Lectures
	Python introduction, Technical strength of Python, Introduction to Python interpreter and program execution, Using comments, Installation of Python, Ways to run Python programmes, Simple input and output, Variable and assignments. Literals, Constants, Numbers (Integers, Floats, Complex Numbers, Real, Sets), Strings (Slicing, Indexing, Concatenation, other operations on strings), Accepting input from console, printing statements, Simple 'Python' programs, Mathematical operators, Permutation and combination. Python as an advanced calculator. Relational, Logical, Bitwise operators and their precedence, Conditional statements: if, if else, if-elif-else, Simple programs, Notion of iterative computation and control flow–range function. While statement, For loop, Break statement, Continue statement, Pass statement, else, assert. **Suggested List of programmes:** 1. Programme to obtain three numbers and print their sum. 2. Programme to obtain the length and breadth of a rectangle and calculate its area. 3. Programme to input a number and print its cube. 4. Programme to input a value in kilometre and convert it into miles. (1 Km = 0.621374 miles) 5. Programme to input a value in tonnes and convert it into quintals and kilogram (1 Ton = 10 quintals=1000 Kg).	
	6. Write a programme to input two numbers and swap them. 7. Write a programme to input three numbers: 1st number becomes 2nd number; 2nd number become 3rd number and 3rd number becomes 1st number. 8. Write a programme to enter two integers and perform all arithmetic operations on them. 9. Write a programme to obtain temperature in Celsius and convert it into Fahrenheit. 10. Write a programme to input three numbers: 2nd number gets the value 1st +2nd, 3rd number gets the value of 2nd +3rd number 11. Programme to find the roots of quadratic equation. 12. Programme that takes a number and check whether the given number is odd or even. 13. Programme to accept three integers and print the largest of three. Make use of only if statement. 14. Programme that input three numbers and calculate two sums as per this: Sum1: as the sum of all input numbers Sum2: as the sum of non-duplicate numbers; If there are duplicate number in the input, ignore them 15. Programme to test the divisibility of a number with another number. 16. Programme that reads three numbers and print them in ascending orders. 17. Programme to print table of a number, say 7.	

	18. Programme to print sum of natural number between any two positive number. 19. Programme to calculate the factorial of a number. 20. Programme to calculate the sum of even and odd integers of first n natural numbers. 21. Programme to implement 'guess the number' game. Python generates a number randomly in the range [10,50]. The user is given five chances to guess a number in the range. 22. Write a programme to illustrate the difference between break and continue statements. 23. Programme to input a number and test if it is a prime number. 24. Programme that searches for prime number from 15 through 25. 25. Write a programme to input three numbers and display the largest/smallest number. 26. Write a programme to input a 6-digit number and divide it into 2 digits number. 27. Write a programme to input a number and then print its first and last digit raised to the length of the number. 28. Write a programme to find lowest and second lowest number from the 10 numbers input. 29. Write a programme to print Fibonacci series. 30. Write a programme to read an integer>1000 and reverse the number. 31. Write a programme to find the sum of the series: $s = 1 + x + x^2 + x^3 \ldots . x^n$ 32. Write a programme to find the sum of the series: $s = 1 - x + x^2 - x^3 + x^4 \ldots . x^n$	
	33. Write a programme to find the sum of the series: $s = 1 + \frac{x}{1!} + \frac{x^2}{2!} + \frac{x^3}{3!} + \cdots + \frac{x^n}{n!}$ 34. If a number is equal to the sum the cubes of its each digit, then it is known as Armstrong Number. Write a programme to check if a given number is an Armstrong Number or not. 35. A number is known as palindrome number if it is same as reversed of it. Write a programme to check if a given number is palindrome number or not.	
	Suggested Readings: **1.** Core Python programming, Dr. R. Nageshwara Rao, Dreamtech Press. **2.** Learning with Python, Allen Downney, Jeffrey Elkner and Chris Meyers, Dreamtech Press. **3.** Let Us Python, Aditya Kanetkar and Yashwant Kanetkar, BPB Publication. **4.** The new python programming for beginners, William J Palmer, Caterina Rosse. **5.** Doing Math with Python: Use Programming to Explore Algebra, Statistics, Calculus, and More!, Amit Saha, No Starch Press. **6.** Mathematics and Python Programming, J. C. Bautista, Lulu Press.	

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:

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

B.Sc. IV (SEMESTER-VIII) PAPER-I Measure Theory

Programme: Degree Honours **Class: B.Sc.**	**Year: Fourth**	**Semester: Eight**
Subject: Mathematics		
Course Code: B030801TN	**Course Title: Measure Theory**	

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	

Measure Theory

Unit	Topics	No. of Lectures
I	Algebra of sets, Borel sets, F_σ and G_δ set, Measure, Finite and σ-finite measure, Complete measure, Regularity of a measure, Lebesgue outer measure, Lebesgue measure, Measurable sets.	**14**
II	Measurable functions, Egoroff's theorem, Borel and Lebesgue measurability, Convergence in measure.	**16**
III	Lebesgue integral of a bounded function, The general Lebesgue integral, Riemann and Lebesgue integrals, Lebesgue bounded convergence theorem, Integration of non-negative measurable functions, Fatau lemma, Lebesgue monotone convergence theorem, Integrable functions, Lebesgue integral of unbounded function, Lebesgue dominated convergence theorem.	**17**
IV	The L^P Spaces, Convex functions, Jensen's inequality, Holder and Minkowski inequalities, Risez Fischer theorem, Convergence in measure.	**13**
	Suggested Readings: **1.** G. de Barra, Measure theory and Integration, New age International (P) Limited publishers **2.** H. L. Royden, Real Analysis, Pearson Education Pvt. Ltd. **3.** P. R. Halmos, Measure theory, D Van Nostrand company. **4.** Parijat Sinha, Real Analysis, Kedarnath Ramnath Publications.	

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:

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

B.Sc. IV (SEMESTER-VIII) PAPER-II Advanced Topology

Programme: Degree Honours **Class: B.Sc.**	**Year: Fourth**	**Semester: Eight**
Subject: Mathematics		
Course Code: B030802TN	**Course Title: Advanced Topology**	

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	

Advanced Topology

Unit	Topics	No. of Lectures
I	Compact sets and their properties, Finite intersection property, Bolzano Weierstrass property, Continuous functions and compactness, Sequential compactness, Countable compactness and their comparison, Locally compact spaces and compactness in real line, totally bounded sets.	14
II	Separated sets, Connectedness in terms of separated sets, Characterization of connected sets in terms of open sets and closed sets, Closure of a connected set, Union of connected sets, Connected sets in R, Continuity of a function and connectedness, Components and partition of space, Locally connected sets, Totally disconnected sets.	17
III	Nets and Filters: Directed sets, Residual subset, Cofinal subset, Nets and subnets and their examples, Convergence of a net, Characterisation of open sets, closed sets, closure, cluster point and limit point of a set in terms of net convergence, Hausdorffness and continuity of a function in terms of nets. Definition of filter and its examples, Free and fixed filters, Discrete and indiscrete filters, Neighbourhood filter, Comparison of filters, Filter base and convergence of a filter, Ultrafilters, Continuous functions and filters, Net based on filter and filter based on net.	17
IV	Quotient topology, Quotient space X/R, Finite product space, Projection mapping, Tychonoff product topology in terms of standard subbase and its characterizations in terms of projection maps, Continuous functions, Product of T_0, T_1, T_2, spaces, Connectedness and compactness, First and second countability for product spaces.	12
	Suggested Readings: **1.** George F. Simmons, Introduction to Topology and Modern Analysis, Mc Graw-Hill Book Company (1963). **2.** J. L. Kelley, General Topology, Van Nostrand, Reinhold Co., New York (1995). **3.** K. D. Joshi, Introduction to General Topology, Wiley Eastern Ltd. (1983). **4.** James R. Munkres, Topology, Prentice Hall of India Pvt. Ltd., New Delhi (2000). **5.** S. Willard, General Topology Addison-Wesley, Reading, 1970. **6.** J. Dugundji, Topology, Allyn and Bacon, 1966 (Reprinted in India by PHI).	

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:

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

B.Sc. IV (SEMESTER-VIII) PAPER-III Operations Research

Programme: Degree Honours **Class: B.Sc.**	**Year: Fourth**	**Semester: Eight**
Subject: Mathematics		
Course Code: B030803TN	**Course Title: 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	

Operations Research

Unit	Topics	No. of Lectures
I	History and development of operations research, Operations research and its scope, necessity of operations research in industry and management, Role of operations research in decision-making, Development of operations research in India, Job sequencing, Convex set and their Application.	13
II	Linear Programming: Theory of simplex method, Duality and sensitivity analysis, Game theory: Two-person, zero-sum games, Games with mixed strategies, Principle of dominance, Solution of 2x2 games without saddle point, Graphical solution, Solution by linear programming.	16
III	Network Analysis: Shortest path problem, Minimum spanning tree problem, Maximum flow problem, Minimum cost flow problem, Project planning and control with PERT-CPM.	16
IV	Non-linear Programming: One and multi-variable unconstrained optimisation, Kuhn-Tucker conditions for constrained optimisation.	15
	Suggested Readings: **1.** Kanti Swarup, P. K. Gupta and Manmohan: Operations Research, S. Chand and Co. **2.** H.A. Taha: Operations Research-An introduction, Macmillan Publishing Co. Inc., New York. **3.** P. K. Gupta and D. S. Hira: Operations Research-An introduction, S. Chand and Co. Ltd. New Delhi.	

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:

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

B.Sc. IV (SEMESTER-VIII) PAPER-IV Mathematical Statistics

Programme: Degree Honours **Class: B.Sc.**	**Year: Fourth**	**Semester: Eight**
Subject: Mathematics		
Course Code: B030804TN	**Course Title: Mathematical Statistics**	

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	

Mathematical Statistics

Unit	Topics	No. of Lectures
I	Random variable, Probability mass function, Probability density function, Cumulative distribution function, Two and higher dimensional random variables, Joint distribution, Marginal and conditional distributions, Stochastic independence, Function of random variables and their probability density functions. Discrete probability distributions: Binomial, Poisson, Geometric, Hyper geometric multinomial. Continuous probability distributions: Exponential, Gamma, Beta, Normal distributions.	**12**
II	Mathematical expectations and moments, Moment generating function and its properties, Chebyshev's inequality and its application, Stochastic convergence, Central limit theorem, Partial and Multiple correlation coefficients, Correlation ratio, Association of attributes.	**16**
III	Sampling Distributions: Chi-square, t and F-distributions with their properties, Distribution of sample mean and variance, Distribution of order statistics and sample range from continuous populations. Applications of Sampling Distributions: Test of mean and variance in the normal distribution, Tests of single proportion and equality of two proportions, Chi-square test, t- test, F-test.	**17**
IV	Testing of Hypothesis: Null hypothesis and its test of significance, Simple and composite hypothesis, MP test, UMP test, Likelihood tests (excluding properties of likelihood ratio tests). Point Estimation: Estimators, Properties of estimators, Unbiasedness, Consistency, Sufficiency, Efficiency.	**15**
	Suggested Readings: **1.** Hogg R.V., Mckean, J. W. and Craig A. T.: Introduction of Mathematical Statistics, Seventh Edition (2013) Pearson India. **2.** Hoel P. G: Introduction to Mathematical Statistics, Fourth Edition ((1971), John Wiley & sons. **3.** Gupta S. C.and Kapoor V. K.: Fundamentals of Mathematical Statistics, (2019) Kedarnath Ramnath pub., Meerut India **4.** Mukhopadhyay, P. : Mathematical Statistics, (2016) Books and Allied Publications. **5.** Goon, A. M.,Gupta M. K. & Das Gupta B.: Fundamental of statistics, Vol. I, (2005), 8th Edition World Press, Kolkata.	

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:

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

B.Sc. IV (SEMESTER-VIII) PAPER-V Computational Mathematics with Python-II

Programme: Degree Honours **Class: B.Sc.**	**Year: Fourth**	**Semester: Eight**
Subject: Mathematics		
Course Code: B030805PN	**Course Title: Computational Mathematics with Python-II**	

Credits: 4	**Practical**
Max. Marks: 25+75	**Min. Passing Marks:**

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

Computational Mathematics with Python-II

Unit	Topics	No. of Lectures
	Introduction and application of SymPy for symbolic computing, Matplotlib Package Application of NumPy for plotting and visualisation, Application of SciPy for Vectors, Matrices, multidimensional array and numerical analysis. **Suggested List of programmes:** 1. Plotting one or multiple Curve (Cartesian, Polar and Parametric). 2. Plotting Curve from Data. 3. Plotting Points. 4. Plotting bar Chart. 5. Plotting Pie Chart. 6. Plotting Histogram. 7. Linear Regression. 8. Matrices and Vectors Operations. 9. Solution of simultaneous equation by I. Matrix Inversion II. Cramer's Rule III. Gauss Elimination IV. Gauss Jordan V. Jacobi Iterative VI. Gauss Seidel	
	10. Solution of Ordinary and Partial differential equation and plotting the solution as curve or surface. 11. Find the root of algebraic/transcendental equation by using I. Fixed point iterative method II. Bisection's Method III. Newton Raphson's Method IV. Secant Method V. Muller's Method VI. Regula Falsi Method	

	Suggested Readings: **1.** Numerical Python, Robert Johansson, Apress publication. **2.** Practical Numerical computing using Python, Mahendra Verma. **3.** Matplotlib Plotting Cookbook, Alexandra Devert, Packt publishing. **4.** Pyton Programming and Numerical Methods guides for Engineers and Scientist, Qiningkai Kong, Timmy Siauw and Alexandre M. Bayen, Academic Press. **5.** Numerical Method in Engineering with Python, Jaan Kiusalaas, Cambridge University Press.3	

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:

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

PG in MATHEMATICS

Detailed Syllabus For

M.Sc. (Integrated)

IN
MATHEMATICS

M.Sc. (Integrated) (SEMESTER-IX) PAPER-I Abstract Algebra

Programme: Master **Class: M.Sc. Integrated**	**Year: Fifth**	**Semester: Ninth**
Subject: Mathematics		
Course Code: B030901TN	**Course Title: Abstract Algebra**	

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

Abstract Algebra

Unit	Topics	No. of Lectures
I	Internal and external direct product of groups and their relationship, Normal and sub normal series of groups, Composition series, Zassenhaus lemma, Schreier theorem, Jordan Holder theorem.	**15**
II	Commutator subgroup and commutator series of a group, Solvable groups, Solvability of subgroups and factor groups and of finite p groups, Lower and upper central series, Nilpotent groups.	**17**
III	Cauchy theorems, Action of a group G on a set, Stabilizer subgroups and orbit decomposition, Class equation of an action, Sylow subgroups, Sylow's theorem I, II and III, p-groups, Examples and applications, Groups of order $p.q$, Direct and inverse images of Sylow subgroups, Structure theorem for finite abelian groups.	**16**
IV	Canonical forms**,** Similarity of linear transformations, Invariant subspaces, Reduction to triangular forms, Nilpotent transformations, Index of nilpotency, Invariants of a nilpotent transformation, The primary decomposition theorem, Jordan blocks and Jordan canonical forms.	**12**
	Suggested Readings: **1.** I. N. Herstein, Topics in Algebra, Wiley student edition **2.** Ram Ji Lal, Algebra I and Algebra II, Springer **3.** Joseph A. Gallian, Contemporary Abstract Algebra, Narosa Publications **4.** John B. Fraleign, A First Course in Abstract Algebra, Narosa Publications **5.** Vijay K. Khanna, S.K Bhambri, A Course in Abstract Algebra **6.** S. Lipschutz, Linear Algebra, Schaum's Outline Series.	

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:

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

M.Sc. (Integrated) (SEMESTER-IX) PAPER-II Functional Analysis

Programme: Master **Class: M.Sc. Integrated**	**Year: Fifth**	**Semester: Ninth**
Subject: Mathematics		
Course Code: B030902TN	**Course Title: Functional 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	

Functional Analysis

Unit	Topics	No. of Lectures
I	Normed linear spaces, Examples of normed linear spaces and its topological properties, Cauchy's inequality, Hölder's and Minkowski's inequality, Convergence in normed linear spaces, Cauchy sequence, Banach space, Examples of Banach space, Quotient space of normed linear space, Equivalent norms, Riesz lemma.	**14**
II	Continuous linear transformation, Bounded linear transformations, Norm of bounded linear transformation, Space of bounded linear transformations. Conjugate space (dual space), Functional, Hahn-Banach theorem for real and complex normed linear spaces, Applications of Hahn- Banach theorem, The natural embedding.	**16**
III	Open mapping theorem, Projection of Banach space, Closed graph theorem, Baire category theorem, Uniform boundedness principle. Inner product spaces, Hilbert spaces with examples, Cauchy-Schwarz's inequality.	**17**
IV	Orthogonal complement, Orthonormal set and its existence, Bessel's inequality, Complete orthonormal sets and its characterization. Continuous linear functional on Hilbert space, Riesz representation theorem, Reflexivity of Hilbert space. Weak and strong convergence.	**13**
	Suggested Readings: **1.** G. F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill, 1963. **2.** S. Ponnusamy, Foundations of Functional Analysis, Narosa Publishing House, New Delhi, 2002. **3.** G. Bachman and L. Narici, Functional Analysis, Academic Press, 1966. **4.** B. V. Limaye, Functional Analysis, Wiley Eastern Ltd. **5.** N. Saran and S. L. Shukla, Functional Analysis, Pragati Prakashan, Meerut. **6.** P. K. Jain, O. P. Ahuja and K. Ahmad, Functional Analysis, New Age International (P) Ltd. And Wiley Eastern Ltd., New Delhi, 1997. **7.** B. Choudhary and S. Nanda, Functional Analysis with Applications, Wiley Eastern Ltd., 1989. **8.** J. N. Sharma and A. R. Vasishtha, Functional Analysis, Krishna Prakashan Media (P) Ltd., 2015.	

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:

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

M.Sc. (Integrated) (SEMESTER-IX) PAPER-III Fluid Dynamics

Programme: Master **Class: M.Sc. Integrated**	**Year: Fifth**	**Semester: Ninth**
Subject: Mathematics		
Course Code: B030903TN	**Course Title: Fluid Dynamics**	

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	

Fluid Dynamics

Unit	Topics	No. of Lectures
I	Types of fluids, Continuum hypothesis, Lagrangian and Eulerian method of describing fluid motion, Equation of continuity in cartesian, Cylindrical polar, Spherical polar and Orthogonal curvilinear coordinates, Vorticity vector, Velocity potential, Stream lines, Path lines and streak lines, Rotational and irrotational motion of fluid, Boundary surface and boundary condition.	**13**
II	Euler's equation of motion: conservation of momentum, Bernoulli's equation, Lagrange's equation of motion, Energy equation, Impulsive effects, Helmholtz's vorticity theorem and vorticity equation, Applications of Bernoulli's equation.	**17**
III	Two dimensional irrotational motion, Stream or current function, Physical significance of stream function, sources, sinks, doublets and their images in two-dimension, Complex potential, The Milne-Thomson circle theorem, Theorem of Blasius, Flow and circulation, Kelvin's circulation theorem, Permanence of irrotational motion, Kelvin's Minimum Kinetic Energy theorem.	**17**
IV	Motion of cylinders: General motion of cylinder in two dimensions, Kinetic energy, Motion of circular, coaxial and elliptic cylinders, Streaming past and circulation for a fixed circular and elliptic cylinder, Kinetic energy of rotating elliptic cylinder, The aerofoil.	**13**
	Suggested Readings: **1.** W.H. Besant and A.S. Ramsey, A Treatise on Hydrodynamics, CBS publishers and Distributors, Delhi, 1988. **2.** R.K. Rathy, An introduction to Fluid Dynamics, Oxford and IBH Publishing Company, New Delhi; 1976. **3.** F. Charlton, A Text Book of Fluid Dynamics, CBC, 1985. **4.** S.W. Yuan, Foundations of Fluid Dynamics, Prentice – Hall of India, 1988.	

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:

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

M.Sc. (Integrated) (SEMESTER-IX) PAPER-IV(i) Special Functions

Programme: Master **Class: M.Sc. Integrated**	**Year: Fifth**	**Semester: Ninth**
Subject: Mathematics		
Course Code: B030904TN	**Course Title: Special Functions**	

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	

Special Functions

Unit	Topics	No. of Lectures
I	Absolute and uniform convergence of infinite products, The Weierstrass's infinite product and Euler's integral for Gamma function and their equivalence, Beta function, Factorial function, Legendre's duplication formula, Gauss' multiplication theorem, Orthogonal sets of functions, orthogonal sets of polynomials, Gram-Schmidt process of orthonormalization.	**12**
II	Hypergeometric function, Integral representation of hypergeometric function and deductions from it, Contiguous function relations, Relations between hypergeometric functions of z and $1-z$, Simple and quadratic transformations of hypergeometric function.	**16**
III	Generalised and confluent hypergeometric function, Formation and solution of differential equation for generalised and confluent hypergeometric function and their contiguous function relations, Saalschutz theorems, Whipple's theorems and Dixon's theorem, Contour integrals of Barnes' type, Hypergeometric forms of Legendre's polynomials.	**16**
IV	Doubly periodic functions, Elliptic functions and their properties, Weierstrass elliptic function and it's differential equation, Theta functions, Properties of theta functions, Relations involving theta functions and differential equations satisfied by theta functions.	**16**
	Suggested Readings: **1.** E. D. Rainvelle: Special Functions, Chelsea Publishing Co., 1971. **2.** N. Saran, S. D. Sharma & T. N. Triuedi: Special Functions, PragatiPrakashan, Meerut. **3.** M. A. Pathan, V. B. L. Chaurasia, P. K. Banerji & M. C. Goyal : Special Functions and Calculus of Variations, Indus Valley Publications, New Delhi, 2004. **4.** Special Functions, Dr. Vinod Kumar, Epsilon Publishing House Pvt. Ltd., Kanpur, 2020.	

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:

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

M.Sc. (Integrated) (SEMESTER-IX) PAPER-IV(ii) Ordinary Differential Equations and Stability Analysis

Programme: Master **Class: M.Sc. Integrated**	**Year: Fifth**	**Semester: Ninth**
Subject: Mathematics		
Course Code: B030905TN	**Course Title: Ordinary Differential Equations and Stability 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	

Ordinary Differential Equations and Stability Analysis

Unit	Topics	No. of Lectures
I	Linear differential equations with constant as well as a variable coefficient, Linear dependence and independence of solutions, Wronskian, Method of undetermined coefficients,Reduction of the order, Initial value problem and equivalent integral equation.	12
II	Picard's iteration method, Lipschitz condition, Existence and uniqueness theorem, An orthogonal set of functions, Boundary value problem, Strum Liouville problem, Green's functions, Ascoli-Arzela theorems, A theorem on convergence of solutions of a family of initial value problems.	16
III	Linear systems, Matrix method for homogeneous first order system of linear differential equations, Fundamental set of solutions, Fundamental matrix of solutions, Wronskian of solutions, Basic theory of the homogeneous linear system, Abel-Liouville formula, Nonhomogeneous linear system, Strum theory, Self-adjoint equations of the second order, Abel formula, Strum separation theorem, Strum fundamental comparison theorem.	16
IV	Nonlinear differential systems, Phase plane, Path, Critical points, Autonomous systems, Isolated critical points, Path approaching a critical point, Path entering a critical point, Types of critical points- Center, Saddle points, Spiral points, Node points, Stability of critical points, Asymptotically stable points, Unstable points, Critical points and paths of linear systems, Almost linear systems, Nonlinear conservative dynamical system, Dependence on a parameter, Liapunov direct method, Limit cycles, Periodic solutions, Bendixson nonexistence criterion, Poincore-Bendixson theorem(statement only), Index of a critical point.	16
	Suggested Readings: **1.** Coddington, E. A., Levinson, N., Theory of ordinary differential equations, Tata McGraw Hill, 2000. **2.** Ross, S. L., Differential equations, John Wiley and Sons Inc., New York, 1984. **3.** Boyce, W. E., Diprima, R. C., Elementary differential equations and boundary value problems, John Wiley and Sons, Inc., New York, 4th edition, 1986. **4.** Simmon, G. F., Differential Equations, Tata McGraw Hill, New Delhi, 1993.	

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:

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

M.Sc. (Integrated) (SEMESTER-IX) PAPER-IV(iii) History and Development of Indian Mathematics

Programme: Master **Class: M.Sc. Integrated**	**Year: Fifth**	**Semester: Ninth**
Subject: Mathematics		
Course Code: B030906TN	**Course Title: History and Development of Indian Mathematics**	

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

History and Development of Indian Mathematics

Unit	Topics	No. of Lectures
I	Indian contributions to decimal system and place value, The mathematical sophistication of the Harappan culture, The Vedic period and the sulva geometry.	12
II	Contribution of the Jainas, Chandas Sutras of Pingala and binary arithmetic, The Baksali Manuscript, Aryabhata I, Varahamihir, Brahmagupta, Bhaskara I.	16
III	Sridharacharya, Mahaveeracharya, Shripati, Aryabhata II, Bhaskaracharya II, Contributions of Kerala school as Madhava, Nilkantha.	16
IV	Srinivasa Ramanujan, Swami Bharati Krishna Tirthaji, Prasanta Chandra Mahalanobis, Prof. Harishchandra.	16
	Suggested Readings: **1.** B. B. Datta and A. N. Singh, History of Hindu Mathematics, 2 Volumes, Bharatiya Kala Prakashan, Delhi,2001. **2.** C. N. Srinivasiengar, The history of Ancient Indian mathematics, World Press, 1988.	

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:

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

M.Sc. (Integrated) (SEMESTER-IX) PAPER-IV(iv) Bio-Mechanics

Programme: Master **Class: M.Sc. Integrated**	**Year: Fifth**	**Semester: Ninth**
Subject: Mathematics		
Course Code: B030907TN	**Course Title: Bio-Mechanics**	

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

Bio-Mechanics

Unit	Topics	No. of Lectures
I	Introduction, Definition and scope of Bio-Mechanics, Role of mathematics in bio-sciences, Basic concepts of fluid dynamics: Navier-Stoke's equation for flow of a viscousincompressible flow, Bio-fluid flows: flows in pipes and ducts, Poiseuille's flow, Applicationof Poiseuille's law for the study of blood flow.	12
II	Basic concepts about blood, Cardiovascular system and blood flows, Blood flow through artery with mild stenosis, Two-layered flow in a tube with mild stenosis, Pulsatile flow of blood, Peristaltic flow in tubes and channels.	16
III	Gas exchange and air flow in lungs, Consumption and transport of oxygen, Weibel's model for flows in lung airways, Comparison between flows of blood and flows in lung airways.	16
IV	Diffusion, Fick's laws of diffusion, Diffusion equation, Modification of the diffusion equation, Diffusion in artificial kidney, Hemodialyser. Types of hemodialyser.	16
	Suggested Readings: **1.** J. N. Kapur: Mathematical Models in Biology and Medicine, Affiliated East-West Press Pvt. Ltd., New Delhi, 1985. **2.** Y. C. Fung: Bio-Mechanics, Springer-VerlagNewYorkInc.,1990. **3.** Stanley E. Charm and George S. Kurland: Blood Flow and Micro circulation, John Wiley &Sons,1974. **4.** S. A. Levin: Frontiers in Mathematical Biology, Springer-Verlag, 1994. **5.** S. K. Pundir & R. Pundir: Biomathematics, Pragati Prakashan, 2010.	

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:

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

M.Sc. (Integrated) (SEMESTER-IX) PAPER-IV(v) Fuzzy Set Theory

Programme: Master **Class: M.Sc. Integrated**	**Year: Fifth**	**Semester: Ninth**
Subject: Mathematics		
Course Code: B030908TN	**Course Title: Fuzzy Set Theory**	

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	

Fuzzy Set Theory

Unit	Topics	No. of Lectures
I	Fuzzy Sets: Basic definitions, α-level sets, Convex fuzzy sets, Basic operations on fuzzy sets, Types of fuzzy sets, Cartesian products. Algebraic products, Bounded sum and difference, t-norms and t conorms.	**12**
II	The Extension Principle: The elements of fuzzy arithmetic, Zadeh's extension principle, Image and inverse image of fuzzy sets, Fuzzy numbers.	**16**
III	Fuzzy Relations and Fuzzy Graphs: Fuzzy relations on fuzzy sets, Composition of fuzzy relations, Min Max composition and its properties, Fuzzy equivalence relations, Fuzzy compatibility relations, Fuzzy relation equations, Fuzzy graphs, Similarity relation.	**16**
IV	Possibility Theory: Fuzzy measures, Evidence theory, Necessity measure, Possibility measure, Possibility distribution, Possibility theory and Fuzzy sets, Possibility theory versus probability theory.	**16**
	Suggested Readings: **1.** Klir, G. J. and Bo Yuan, Fuzzy Sets and Fuzzy Logic, Prentice Hall of India, New Delhi 1995 **2.** Zimmermann, H. J., Fuzzy Set Theory and Its Applications, Allied Publishers Ltd, New Delhi 1991 **3.** Ross, T. J., Fuzzy Logic with Engineering Applications, McGraw Hill Inc., New Delhi **4.** Backzinski, M. and J Balasubramanian, Fuzzy Implications, Springer Verlag, Heidelberg 2008.	

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:

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

M.Sc. (Integrated) (SEMESTER-IX) PAPER-IV(vi) Programming in C

Programme: Master **Class: M.Sc. Integrated**	**Year: Fifth**	**Semester: Ninth**
Subject: Mathematics		
Course Code: B030909TN	**Course Title: Programming in C**	

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	

Programming in C

Unit	Topics	No. of Lectures
I	Overview of C: History and importance of C, Sample Programs, Programming Style, Executing a 'C' programme, Constants, Variables and data type. Operators: Arithmetic, Relational, Logical, Assignment, Increment and Decrement, Conditional, Bitwise, Special. Expressions: Arithmetic expressions, evaluation of expressions, Input and output operators.	12
II	Decision Making and Branching: Decision making with if statement, simple if statement, the if-else statement, Nesting of if-elsestatements, The else if Ladder, The Switch statement, The Goto statement.	16
III	Decision Making and Looping: The while statement, The do statement, The for statement, Jump in Loop. Arrays: One and two-dimensional arrays, Declaration of one and two-dimensional arrays, Initializing of one and two-dimensional arrays, Multi-dimensional arrays, Dynamic arrays, Character arrays and strings.	16
IV	User-defined Functions: Need for user-defined functions, A multi-function program, Elements of user-defined functions, Definition of functions, Functions call, Functions declaration, Category of function, Nesting of functions. Pointers: Understanding pointers, Declaring pointer variables, Initializing of pointervariables, Accessing a variable through its pointer, Chain of pointers, Pointers and arrays, Pointer as a function argument, File management in C.	16
	Suggested Readings: **1.** E. Balagurusamy: Programming in ANSI C, MacGraw Hill Education (India) Pvt. Ltd., New Delhi. **2.** Yashavant Kanetkar, Let us C, BPB Publications, India.	

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:

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

M.Sc. (Integrated) (SEMESTER-IX) PAPER-IV(vii) Vedic Ganita

Programme: Master **Class: M.Sc. Integrated**	**Year: Fifth**	**Semester: Ninth**
Subject: Mathematics		
Course Code: B030910TN	**Course Title: Vedic Ganita**	

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	

Vedic Ganita

Unit	Topics	No. of Lectures
I	History of Vedic Ganita, Why Vedic Ganita, Silent features of Vedic Ganita, Vedic Ganita formulas, 16 sutras, 13 sub sutras, Terms and operations, High speed addition by using the concept of computing the whole and from left to right, Superfast subtraction by Nikhilamsutram from basis 100, 1,000, 10,000.	**12**
II	Multiplication by Urdhavtrighbhyam sutram, Multiplication by vinculum sutram, Multiplication by Nikhilam sutram, Fast multiplication by 11, Multiplication of numbers consisting of all 9s, Multiplication of numbers nearest to the base 10 and multiplication of numbers with sub base 50,500,5000.	**16**
III	Meaning of Ekadhiken sutram and its applications in finding squaring of numbers ending in 5, squares by Anurupeyana sutram, Square by Yavdunam thava dunikritya vargamcha yojyet sutram, Squaring by Dwandvayoga sutram, Squaring numbers nearest 50, Square roots of perfect square, General method of square roots, Cubes by Anurupeyana sutram.	**16**
IV	Decimal and fractions, Division by Nikhilam Sutram, Division of 1/19, 1/29 by Ekadhikenpurven sutram, Division by Paravartya sutram, Division by Anurupeyana sutram, Division of polynomials, Factors of general second-degree equation by Lopsthapanabhyam sutram.	**16**
	Suggested Readings: **1.** Vedic Mathematics, published by Motilal Banarasi Das 1965. ISBN 81-2 08-0163-6. **2.** Vedic Ganita: Vihangam Drishti-1, Shiksha Sanskriti Utthan Nyasa, New Delhi	

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:

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

M.Sc. (Integrated) (SEMESTER-X) PAPER-I Advanced Abstract Algebra

Programme: Master **Class: M.Sc. Integrated**	**Year: Fifth**	**Semester: Tenth**
Subject: Mathematics		
Course Code: B031001TN	**Course Title: Advanced Abstract Algebra**	

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	

Advanced Abstract Algebra

Unit	Topics	No. of Lectures
I	Field theory, Extension fields, Minimal polynomial of an algebraic element, Algebraic and transcendental extensions, Splitting fields, Primitive elements, Separable and inseparable extensions, Perfect fields.	14
II	Automorphisms of fields, Fixed fields, Normal extensions, Galois extensions, Fundamental theorem of Galois theory, algebraically closed fields, Prime fields, Finite fields.	16
III	Solution of polynomial equations by radicals, Constructible numbers. Modules, Direct product of modules, Cyclic modules, Sub modules, quotient modules, Fundamental theorem of homomorphism of modules.	17
IV	Free Modules, Simple modules, Semi-simple modules, Schur's lemma, Noetherian and Artinian modules and rings, Hilbert basis theorem, Wedderburn-Artin theorem, Uniform modules, Primary modules, Noether-Lasker theorem.	13
	Suggested Readings: **1.** I.N. Herstein, Topics in Algebra, Wiley student edition **2.** Ram Ji Lal, Algebra I and Algebra II, Springer **3.** Joseph A. Gallian, Contemporary Abstract Algebra, Narosa Publications **4.** John B. Fraleign, A First Course in Abstract Algebra, Narosa Publications **5.** Vijay K. Khanna, S.K Bhambri, A Course in Abstract Algebra, Vikas Publishing House **6.** Bhattacharya, Jain and Nagpaul, Basic Abstract Algebra, Cambridge University Press	

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:

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

M.Sc. (Integrated) (SEMESTER-X) PAPER-II Integral Equations and Boundary Value Problems

Programme: Master **Class: M.Sc. Integrated**	**Year: Fifth**	**Semester: Tenth**
Subject: Mathematics		
Course Code: B031002TN	**Course Title: Integral Equations and Boundary Value Problems**	

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	

Integral Equations and Boundary Value Problems

Unit	Topics	No. of Lectures
I	Definition of integral equations, Types of integral equations, Kernel, Fredholm and Volterra integral equations, Verification of solution of integral equation, Conversion of integral equation to differential equation and vice-versa, Initial value problem & Volterra integral equation, Boundary value problem and Fredholm integral equation.	14
II	Solution of Fredholm integral equation by method of successive approximation, Resolvent kernel, Solution of Fredholm integral equation by method of resolvent kernel, Solution of Volterra integral equation by method of successive approximation, Solution of Volterra integral equation by method of successive substitution, Fredholm determinant, Convergence of Fredholm series.	17
III	Solution of integral equations by method of Laplace transform, Convolution type kernel, Solution of integral equation by Fourier transform method, Singular integral equation, Cauchy and Hilbert type kernel, Solution of singular integral equation having kernel of $h(s) - h(t)$ type.	17
IV	Boundary value problem, Initial value problem, Green's function. Construction of Green's function from given boundary value problem, Applications of Green's function, Modified Green's function, Dirac Delta function.	12
	Suggested Readings: **1.** Linear integral equations theory & techniques, R.P. Kanwal Academic Press New York 1971. **2.** Linear integral equation & boundary value problem by M. D. Rai Singhania, S. Chand & Co. 2005. **3.** Integral Equation by Shanti Swaroop, Krishna Prakashan, 1989. **4.** A first course in integral equation, A M Wazwar, Saint Xavier Univ. USA Dec 1997.	

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:

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

M.Sc. (Integrated) (SEMESTER-X) PAPER-III(i) Advanced Fluid Mechanics

Programme: Master **Class: M.Sc. Integrated**	**Year: Fifth**	**Semester: Tenth**
Subject: Mathematics		
Course Code: B031003TN	**Course Title: Advanced Fluid Mechanics**	

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	

Advanced Fluid Mechanics

Unit	Topics	No. of Lectures
I	Three dimensional irrotational flow, Axisymmetric flow, Strokes Stream function, Axisymmetric potential flow, Liquid streaming past a stationary sphere, Uniform motion of a sphere in a liquid at rest at infinity, Concentric sphere (problem of initial motion).	**13**
II	Vortex motion, Vortex filament, Complex potential, Image of vortex, Complex potential due to vortex doublet, Spiral vortex, Rankine combined vortex, Rectilinear vortex with elliptic cross-section, Routh's theorem, Motion of any vortex, Kirchhoff vortex theorem.	**16**
III	Newton's Law of viscosity, Newtonian and non-Newtonian fluids, Definition of stress, strain and their relations, Relation between stresses and rate of strain, Navier-Stoke's equation, Dissipation of energy, Diffusion of vorticity, Laminar flow of Viscous incompressible fluids.	**16**
IV	Fluid pressure: Equation of pressure, Condition of equilibrium, Lines of force, Homogeneous and heterogeneous fluids, Elastic fluids, Surface of equal pressure and density, Rotating fluids. Fluid pressure on plane surface: Centre of pressure, Resultant pressure on curved surfaces.	**15**
	Suggested Readings: **1.** W.H. Besant and A.S. Ramsey, A Treatise on Hydrodynamics, CBS publishers and Distributors, Delhi, 1988. **2.** R.K. Rathy, An introduction to fluid Dynamics, Oxford and IBH Publishing Company, New Delhi; 1976. **3.** F. Charlton, A Text Book of Fluid Dynamics, CBC, 1985. **4.** S.W. Yuan, Foundations of Fluid Dynamics, Prentice – Hall of India, 1988. **5.** B. D. Sharma, Hydro-statics, Kedar Nath Ram Nath Publication.	

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:

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

M.Sc. (Integrated) (SEMESTER-X) PAPER-III(ii) Wavelet Analysis

Programme: Master **Class: M.Sc. Integrated**	**Year: Fifth**	**Semester: Tenth**
Subject: Mathematics		
Course Code: B031004TN	**Course Title: Wavelet 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	

Wavelet Analysis

Unit	Topics	No. of Lectures
I	Fourier transforms, Inverse Fourier transforms, Basic properties of Fourier and inverse Fourier transforms, Convolution and delta function, Fourier transform of square integrable functions, Poisson's summation formula.	**13**
II	Construction of wavelets on Z_N , Haar wavelets on Z , Shannon wavelet, The Gabor transform, Heisenberg uncertainty principle, Description of $l^2(Z)$, Parseval's relation.	**16**
III	$L^2[-\pi, \pi]$ and $L^2(R)$, Multi resolution analysis, MRA wavelets, Scaling functions with finite two scale relations, Direct sum decomposition of $L^2(R)$, Linear phase filtering, Low-pass filters and scaling functions, Compactly supported wavelets, Wavelets and their duals.	**16**
IV	Franklin wavelets on $\mathbb{R}$, Orthogonal wavelets and wavelet packets, Example of orthogonal wavelets, Identification of wavelet packets, Construction of compactly supported orthogonal wavelets, Orthogonal wavelet packets, Orthogonal decomposition of wavelet series.	**15**
	Suggested Readings: **1.** C. K. Chui, An Introduction to Wavelets, Academic Press, 1992. **2.** I. Daubechies, Ten Lectures on Wavelets, CB5-NSF Regional Conference in Applied Mathematics, 61, SIAM, 1992. **3.** M. W. Frazier, An Introduction to Wavelets through Linear Algebra, Springer-Verlag, 1999. **4.** E. Hernandez and G. Weiss, A First Course on Wavelets, CRC Press, 1996.	

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:

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

M.Sc. (Integrated) (SEMESTER-X) PAPER-III(iii) Special Theory of Relativity

Programme: Master **Class: M.Sc. Integrated**	**Year: Fifth**	**Semester: Tenth**
Subject: Mathematics		
Course Code: B031005TN	**Course Title: Special Theory of Relativity**	

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	

Special Theory of Relativity

Unit	Topics	No. of Lectures
I	Historical background and postulates of special relativity, Relativity of simultaneity, Lorentz transformation and its consequences, Relativistic addition of velocities.	13
II	Doppler effect, Space-time diagrams, Time order and Space-time separation of events, Null cone, The twin-paradox.	16
III	Relativistic mass and momentum, The equivalence of mass and energy, The relativistic force law and dynamics of a single particle, Energy momentum tensor of incoherent matter.	16
IV	Principle of equivalence, Principle of general covariance, Criteria for gravitational field equations, Einstein field equations, Gravity as a geometric Phenomenon. The energy momentum tensor, Inclusion of forces in the field equations and their classical limits.	15
	Suggested Readings: **1.** Rindler W. Special Relativity, 1966. **2.** Resnick, R., Introduction to special relativity, Wiley-Eastern, 1990. **3.** Special Theory of Relativity, Anshan Publishers-2009.	

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:

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

M.Sc. (Integrated) (SEMESTER-X) PAPER-III(iv) Differential Geometry of Manifolds

Programme: Master **Class: M.Sc. Integrated**	**Year: Fifth**	**Semester: Tenth**
Subject: Mathematics		
Course Code: B031006TN	**Course Title: Differential Geometry of Manifolds**	

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	

Differential Geometry of Manifolds

Unit	Topics	No. of Lectures
I	Analysis of curve, Curvatures related to curves, Curvature tensor, Torsion tensor and skew curvature tensor, Examples based on curvature tensor, Torsion tensor and skew curvature tensor, Relation between curvature tensor and their derivatives, Study of surface, Analytical study of first and second fundamental form of surfaces.	**13**
II	Tensor space, Dimension and basis of tensor space, Rank of tensor, Quotient law of tensor, Uses of Christoffel symbols in real world, Analysis and uses of gradient, divergence and curl.	**16**
III	C^r-curve, Chart, Atlas, Definition of topological manifold, Differentiable manifold, Examples of manifold, One dimensional manifold, Examples of two-dimensional manifold, three dimensional and n-dimensional manifolds, Tangent space, Tangent bundle, Lie groups, Lie derivative.	**16**
IV	Complex manifolds, Examples of complex contact manifolds, Contact manifold, Examples of contact manifolds, Difference of complex and contact manifold.	**15**
	Suggested Readings: **1.** Elementary Topics in Differential Geometry, Thorpe J.A, Springer 1994. **2.** Tensor calculus, De UC, Shaikh AA, Sengupta Joydeep, 2005 **3.** An introduction to differentiable manifold, Willmore T.J **4.** A Course of Tensors with Applications, Mishra R.S, Pothishala Pvt Ltd,1965. **5.** Differential Geometry of Manifolds, De.U.C Narosa Publishing House 2005 **6.** Complex and Contact Manifold, De U.C Narosa Publishing House,2008.	

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:

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

M.Sc. (Integrated) (SEMESTER-X) PAPER-III(v) Advanced Discrete Mathematics

Programme: Master **Class: M.Sc. Integrated**	**Year: Fifth**	**Semester: Tenth**
Subject: Mathematics		
Course Code: B031007TN	**Course Title: Advanced Discrete Mathematics**	

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	

Advanced Discrete Mathematics

Unit	Topics	No. of Lectures
I	Semigroups and Monoids: Definitions and examples of semigroups and monoids (including those pertaining to concatenation operation), Homomorphism of semigroups and monoids, Congruence relation and quotient semigroup, Subsemigroup and submonoids, Direct products, Basic homomorphism theorem.	13
II	Lattices: Lattices as partially ordered sets and their properties, Lattices as algebraic systems, Sub-lattices, Direct products and homomorphisms, Some special lattices such as complete, complemented and distributive lattices.	16
III	Boolean Algebra: Boolean algebras as lattices, Various Boolean identities, The switching algebra example, Sub-algebras, Direct products and homomorphisms, Join-irreducible elements, Atoms and minterms, Boolean forms and their equivalence, Minterm Boolean forms, Sum of products, Canonical forms, Minimization of the Boolean functions.	16
IV	Grammars and Languages: Phrase structure grammars, Rewriting rules, Derivations, Sentential forms, Language generated by grammar, Regular, Context free and Context sensitive grammar and languages, Regular sets, Regular expressions and the pumping lemma, Kleene's theorem, Notions of syntax analysis, Polish notations, Conversion of infix expressions to Polish notations, The reverse Polish notations.	15
	Suggested Readings: **1.** J.P. Tremblay & R. Manohar, Discrete Mathematical Structures with Applications to Computer Science, Tata McGraw-Hill Publishing Company Limited. **2.** C.L. Liu, Elements of Discrete Mathematics, Tata McGraw-Hill Publishing Company Limited. **3.** H.K. Pathak & J.P. Chauhan, Advanced Discrete Mathematics, Shiksha Sahitya Prakashan.	

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:

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

M.Sc. (Integrated) (SEMESTER-X) PAPER-IV(i) Operator Theory

Programme: Master **Class: M.Sc. Integrated**	**Year: Fifth**	**Semester: Tenth**
Subject: Mathematics		
Course Code: B031008TN	**Course Title: Operator Theory**	

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	

Operator Theory

Unit	Topics	No. of Lectures
I	Introduction to real Banach and real Hilbert spaces, Adjoint of an operator on a Hilbert space, Self-adjoint operators, Normal operators and Unitary operators on Hilbert spaces, Projections on a Hilbert space.	**12**
II	Compact operators, Spectral theory of linear operators in normed linear space, Spectral theory of linear operators in finite dimensional normed linear spaces, Spectral properties of bounded linear operators.	**16**
III	Determinant and the spectrum of an operator, Spectral theorem, Resolvent and its properties, Spectrum and its properties, Residual spectrum, Approximate spectrum, Analyticity of the resolvent operator, Use of complex analysis in spectral theory, Spectral radius and the spectral mapping theorem for polynomials.	**17**
IV	Banach algebras, Banach algebras with identity, Division algebra, Further properties of Banach algebra, Compactness of the spectrum, Ideals and maximal ideals of a complex commutative Banach algebra, radicals, Gelfand-Naimark theorem.	**15**
	Suggested Readings: **1.** G. F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill, 1963. **2.** E. Kreyszig, Introductory Functional Analysis with Applications, John Wiley and Sons. **3.** G. Bachman and L. Narici, Functional Analysis, Academic Press, New York, 1966. **4.** J. B. Convey, A Course in Operator Theory, Springer. **5.** N. Saran and S. L. Shukla, Functional Analysis, Pragati Prakashan, Meerut. **6.** J. N. Sharma and A. R. Vasishtha, Functional Analysis, Krishna Prakashan Media (P) Ltd., 2015.	

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:

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

M.Sc. (Integrated) (SEMESTER-X) PAPER-IV(ii) Calculus of Variations

Programme: Master **Class: M.Sc. Integrated**	**Year: Fifth**	**Semester: Tenth**
Subject: Mathematics		
Course Code: B031009TN	**Course Title: Calculus of Variations**	

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	

Calculus of Variations

Unit	Topics	No. of Lectures
I	Evolution of calculus of variations and contribution of Bernoulli. Functional, Euler's equation of extrema for functionals involving first order derivative, Functional dependent on more than one dependent variables, Functional dependent on two independent variables: Euler Ostrogradsky equation, Generalised Eular's Ostrogradsky Equation. Functional dependent on higher order derivative: Euler Poisson's equation.	**12**
II	Weierstrass function, Sufficient condition of Extrema: Legendre condition, Isoperimetric problem, Local maxima, Invariance of Euler's equation under coordinate transformation, Problems based on Legendre condition.	**16**
III	Moving boundary value problem, Condition of extrema: Transversality condition, Variational problem with movable boundary for a functional dependent on two functions, One sided variation, Reflection & refraction of extremals, Diffraction of light rays.	**17**
IV	Field extremal, Jacobi condition, Second variation, Canonical equations, Applications of calculus of variations in Lagrarge's equation, Application of calculus of variations in the Hamilton's equation, Hamiltons variational principle.	**15**
	Suggested Readings: **1.** Calculus of Variations with Applications, AS Gupta, Printice Hall of India,1997. **2.** Calculus of Variations, I.M. Gelfand and S.V. Fomin, Dover Publication, 2000. **3.** Calculus of Variations, Mukesh Singh, Krishna Publications, 2015.	

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:

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

M.Sc. (Integrated) (SEMESTER-X) PAPER-IV(iii) Mathematical Modelling

Programme: Master **Class: M.Sc. Integrated**	**Year: Fifth**	**Semester: Tenth**
Subject: Mathematics		
Course Code: B031010TN	**Course Title: Mathematical Modelling**	

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	

Mathematical Modelling

Unit	Topics	No. of Lectures
I	Introduction to mathematical modelling: need, classification, modelling process, Elementary mathematical models; Role of mathematics in problem solving. Single species population model: The exponential model and the logistic model, Harvesting model and its critical value.	**12**
II	Modelling with ordinary differential equations: Overview of basic concepts in ODE and stability of solutions: steady state and their local and global stability, Linear and non-linear growth and decay models. Compartment models. Mathematical modelling of geometrical problems, reaction kinetics. Some applications in economics, ecology, Modelling in epidemiology (SIS, SIR, SIRS models) and basic reproduction number.	**16**
III	Mathematical models through difference equations, Some simple models, Basic theory of linear difference equations with constant coefficients, Mathematical modelling through difference equations in economics and finance, Mathematical modelling through difference equations in population dynamics.	**17**
IV	Mathematical modelling through partial differential equations, Situations giving rise to of partial differential equation models. The one-dimensional heat equation: derivation and solution. Wave equation: derivation and solution.	**15**
	Suggested Readings: **1.** J.N. Kapur, Mathematical Modelling, New Age Intern. Pub. **2.** J.N. Kapur, Mathematical Models in Biology and Medicine, East-West Press. **3.** Fred Brauer and Carlos Castillo-Chavez, Mathematical Models in Population Biology and Epidemiology, Springer. **4.** Frank R. Giordano, William Price Fox, Maurice D. Weir, A First Course in Mathematical Modelling, 4th Ed., Charlie Van Wagner. 5. Walter J. Meyer, Concept of Mathematical Modelling, McGraw-Hill. **5.** Zafar Ahsan: Differential Equations and Their Applications, PHI learning Private Limited, New Delhi. **6.** Steven H. Strogatz, Nonlinear dynamics and chaos, With Applications to Physics, Biology, Chemistry, and Engineering.	

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:

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

M.Sc. (Integrated) (SEMESTER-X) PAPER-IV(iv) Cosmology

Programme: Master **Class: M.Sc. Integrated**	**Year: Fifth**	**Semester: Tenth**
Subject: Mathematics		
Course Code: B031011TN	**Course Title: Cosmology**	

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	

Cosmology

Unit	Topics	No. of Lectures
I	Mach's principle, Einstein modified field equations with cosmological term, Static cosmological model of Einstein and De-Sitter, Their derivation, Properties and comparison with the actual universe.	**12**
II	Hubble's law, Cosmological principles, Weyl's postulate. Derivation of Robertson-Walker metric, Hubble and deacceleration parameters, Redshifts, Redshift versus distance relation, Angular size versus redshift relation and source counts in Robertson-Walker space-time.	**16**
III	Friedmann models, Fundamental equation of dynamical cosmology, Critical density, Closed and open Universe, Age of the Universe, Matter dominated era of the Universe, Einstein- De Sitter model, Particle and even horizons.	**17**
IV	Eddington-Lamaitre models with I- term, Perfect Cosmological principle, Steady state Cosmology.	**15**
	Suggested Readings: **1.** R. C. Tolman, Relativity, Thermodynamics and Cosmology, Clarendon Press, Oxford, 1934. **2.** S. Weinberg, Gravitation and Cosmology, John Wiley, 1972. **3.** J. V. Narlikar, Introduction to Cosmology, Cambridge University Press, 1998. **4.** J. N. Islam, An Introduction to Mathematical Cosmology, Cambridge University Press, 1999. **5.** J. A. Peacock, Cosmological Physics, Cambridge University Press, 1999.	

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:

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