Nehru Gram Bharati (Deemed to be University)
Prayagraj, Uttar Pradesh , INDIA

Syllabus

[As per NEP-2020 Regulations]

Bachelor of Science (Honours)/(Honours with Research)
in
Mathematics

[Department of Mathematics]

[Effective From 2023-24 Onwards]

Board of Studies

Dated: 03-06-2023

1. Dr. Archana Shukla, Head, Department of Mathematics, NGB (DU), Chairperson

2. Dr. Vikram Singh, HOD &Assistant Professor, Dept. of Physics, NGB (DU), Member

3. Mr. Vijay Kumar, Assistant Professor, Dept. of Mathematics, NGB (DU), Member

4. Prof. Neeta Singh, Ex-Head, Department of Mathematics, University of Allahabad, Subject Expert

6. Prof. A.K. Malik, Department of Mathematics, UPRTOU, Prayagraj, Subject Expert

Attendance Sheet & Minutes

(Deemed to be University U/s-3 of UGC Act 1956)

NEHRU GRAM BHARATI

(DEEMED TO BE UNIVERSITY)

Kotwa-Jamunipur-Dubawal, Prayagraj-221505, Uttar Pradesh (INDIA)

Administrative Office :
Hanumanganj Campus,
G.T. Road, Hanumanganj, Prayagraj-221505,
Uttar Pradesh
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Minutes of the Meeting

Resolutions

Board of Studies (BoS) of the department of Mathematics, Nehru Gram Bharati (Deemed to be University), Prayagraj was held on 3rd day of June, 2023 at Shashi Campus, Jhuthi Tali, Praygraj with following Agenda.

The Agenda for the meeting is listed below:

1. Confirmation of the minutes of past meeting.
2. To consider, and accept the syllabi prepared for the 4 yrs UG Programme (under the NEP 2020) for the department of Mathematics.
3. Any other matter with the permission of the Chairperson.

Members Attending:

1. Dr. Archana Shukla, HoD, Mathematicss, NGB (DU), Chairman.
2. Dr. Vikram Singh, (HoD) Assistant Professor, Physics Department, NGB (DU), Member.
3. Mr. Vijay Kumar, Assistant Professor, Mathematics Department, NGB (DU), Member.
4. Prof. A. K. Malik, Department of Mathematics, UPRTU, Prayagraj, External Expert.

Members Absent:

1. Prof. Neeta Singh, Department of Mathematics, A.U., Prayagraj, External Expert.

The following resolutions were made during the meeting:

1 The minutes of the last meeting of BoS held on 06 January were confirmed.
2 Considered and accepted the syllabi prepared for the 4 yrs UG Programme (under the NEP 2020) for the department of Mathematics. It was decided by committee members.

The meeting ended with a vote of thanks to the Chair.

Enclosures:

1. Supportive documents (with signature of all attending members) to be presented agenda wise.

Introduction of the Programme:

[a] Introduction:

The NEP-2020 offers an opportunity to effect a paradigm shift from a teacher-centric to a student-centrichighereducationsysteminIndia.ItisbasedonOutcomeBasedEducation,wheretheGraduate Attributes are first kept in mind to reverse-design the Programs, Courses and Supplementary activitiestoattainthegraduateattributesandlearningoutcomes.Thelearningoutcomes-basedcurriculumframeworkforadegreeinB.Sc. (Honours/Honours with Research) in Mathematicsisintendedtoprovideacomprehensive foundation to the subject and to help students develop the ability to successfullycontinuewithfurtherstudiesandresearchinthesubjectwhiletheyareequippedwithrequiredskills at various stages. The framework is designed to equip students with valuable cognitive abilities andskills so that they are successful in meeting diverse needs of professional careers in a developing andknowledge-based society. The curriculum framework takes into account the need to maintain globallycompetitive standards of achievement in terms of the knowledge and skills, as well as todevelop Scientific temper, spirit of enquiry, problem solving skills and human and professionalvalueswhich fosterrationaland criticalthinkingin students.

[b] Graduate Attributes:

Type oflearningoutcomes	**TheLearningOutcomesDescriptors**
Learningoutcomes thatarespecifictodisciplinary/ Interdisciplinaryareasoflearning	Disciplinary/ interdisciplinary Knowledge & Skills
Genericlearningoutcomes	***Critical Thinking &problem-solving Capacity***
	Creativity
	CommunicationSkills: Thegraduatesshouldbeabletodemonstratetheskillsthatenablethemto: • listencarefully,readtextsandresearchpapersanalytically,andpresentcomplexinformation inaclearandconcisemannertodifferentgroups/audiences, • express thoughts and ideas effectively in writing and orally and communicate with othersusingappropriatemedia, • confidentlyshareviewsandexpressherself/himself, • construct logical arguments using correct technical language related to a field of learning,work/vocation,oranareaofprofessionalpractice, • conveyideas,thoughts,andargumentsusinglanguagethatisrespectfulandsensitivetogenderandotherminoritygroups.
	Analyticalreasoning/thinking: Thegraduatesshouldbeabletodemonstratethecapabilityto: • evaluatethereliabilityandrelevanceofevidence; • identifylogicalflawsintheargumentsofothers; • analyzeandsynthesizedatafromavarietyofsources; • drawvalidconclusionsandsupportthemwithevidenceandexamples,andaddressing opposingviewpoints.

	Research-relatedskills: Thegraduatesshouldbeabletodemonstrate: • a keen sense of observation, inquiry, and capability for asking relevant/ appropriatequestions, • theabilitytoproblematize,synthesizeandarticulateissuesanddesignresearchproposals, • the ability to define problems, formulate appropriate and relevant research questions,formulatehypotheses,testhypothesesusingquantitativeandqualitativedata,establishhypotheses,makeinferencesbasedontheanalysisandinterpretationofdata,and predictcause-and-effectrelationships, • thecapacity todevelopappropriatemethodologyandtools of datacollection, • theappropriateuseofstatisticalandotheranalyticaltoolsandtechniques, • theability toplan,executeandreport theresultsofanexperiment orinvestigation, • theabilitytoacquiretheunderstandingofbasicresearchethicsandskillsinpracticing/doingethicsin thefield/inpersonal researchwork,regardlessofthefundingauthority orfield of study.
	Coordinating/collaboratingwithothers:The graduatesshould beabletodemonstratetheabilityto: • workeffectivelyandrespectfullywithdiverseteams, • facilitatecooperativeorcoordinatedeffortonthepartofagroup, • acttogetherasagrouporateamintheinterestsofacommoncauseandworkefficientlyas amemberofateam.
	Leadershipreadiness/qualities: Thegraduatesshouldbeabletodemonstratethecapabilityfor: • mappingoutthetasksofateamoranorganizationandsettingdirection. • formulatinganinspiringvisionandbuildingateamthatcanhelpachievethevision,motivatingandinspiringteammemberstoengagewiththatvision. • usingmanagementskillstoguidepeopletotherightdestination.
	'Learninghowtolearn'skills: The graduatesshouldbeabletodemonstrate theabilityto: • acquire new knowledge and skills, including 'learning how to learn' skills, that arenecessary for pursuing learning activities throughout life, through self-paced and self-directed learning aimed at personal development, meeting economic, social, and culturalobjectives, and adapting to changing tradesand demands of the workplace, includingadaptingtothechangesinworkprocessesinthecontextofthefourthindustrialrevolution,throughknowledge/skilldevelopment/reskilling,
	• workindependently,identifyappropriateresourcesrequiredforfurtherlearning, • acquireorganizationalskillsandtimemanagementtosetself-definedgoalsandtargetswithtimelines. • inculcateahealthyattitudetobealifelonglearner,
	Digitalandtechnologicalskills: Thegraduatesshouldbeabletodemonstratethecapabilityto: • useICTinavarietyoflearningandworksituations, • access,evaluate,anduseavarietyofrelevantinformationsources, • useappropriatesoftwareforanalysisofdata.
	• ***National & International Perspective considering the current perspective of a Global Village.***
	Value inculcation: The graduates should be able to demonstrate the acquisition of knowledgeandattitudethatarerequiredto: • embraceandpracticeconstitutional,humanistic,ethical, andmoralvalues in life,including universal human values of truth, righteous conduct, peace, love, nonviolence,scientifictemper,citizenshipvalues, • practiceresponsibleglobalcitizenshiprequiredforrespondingtocontemporaryglobal

	challenges, enabling learners to become aware of and understand global issuesand to become active promoters of more peaceful, tolerant, inclusive, secure, andsustainablesocieties, • formulateaposition/argumentaboutanethicalissuefrommultipleperspectives • identifyethicalissuesrelatedtowork,andfollowethicalpractices,includingavoidingunethicalbehaviorsuchasfabrication,falsificationormisrepresentation of data, orcommitting plagiarism, and adhering tointellectualpropertyrights, • recognize environmental and sustainability issues, and participate in actions to promotesustainabledevelopment.
	Autonomy, responsibility, and accountability: The graduates should be able to demonstratetheabilityto: • applyknowledge,understanding,and/orskillswithanappropriatedegreeofindependencerelevanttothelevelofthequalification, • work independently, identify appropriate resources required for a project, and manage aprojectthroughtocompletion,
	Environmental awareness and action: The graduates should be able to demonstrate theacquisition of and ability to apply the knowledge, skills, attitudes, and values required to takeappropriateactionsfor: • mitigatingtheeffectsofenvironmentaldegradation,climatechange,andpollution, effective waste management, conservation of biological diversity, management of biologicalresourcesandbiodiversity,forestandwildlifeconservation,andsustainabledevelopmentandliving.
	Communityengagementandservice: Thegraduatesshouldbeabletodemonstratethecapabilitytoparticipateincommunity-engagedservices/activitiesforpromotingthewell-beingofsociety.
	Empathy: The graduates should be able to demonstrate the ability to identify with orunderstand the perspective, experiences, or points of view of another individual or group, andtoidentifyandunderstandotherpeople'semotions.

[c] Flexibility:

The programmes are flexible enough to allow liberty to students in designing them according to their requirements. The Learner is given freedom of choice in selecting disciplines. Students may select his/her own stream. He/She may select three major disciplines from his her own stream or two major disciplines from his own stream and one major discipline from any other stream . Alongwith major disciplines, a student can select minor disciplines from other streams, languages, generic electives, ability enhancement courses, Vocational/Skill Enhancement Courses (SEC) and Value added Courses including Extra Curricular activities.

Multiple Entry & Exit Options:

EXIT OPTIONS	Credits Required
Certificate upon the Successful Completion of the First Year (Two Semesters) of the multidisciplinary Four-year Undergraduate Programme.**[NSQF Level 5]**	**44**
Diploma upon the Successful Completion of the Second Year (Four Semesters) of the multidisciplinary Four-year Undergraduate Programme. **.[NSQF Level 6]**	**88**
Basic Bachelor Degree at the Successful Completion of the Third Year (Six Semesters) of the multidisciplinary Four- year Undergraduate Programme.	**136**
Bachelor Degree with Honours/Honours with Research in a Discipline at the Successful Completion of the Fourth Year (Eight Semesters) of the multidisciplinary Four-year Undergraduate Programme.	**180**

Programme Educational Objectives(PEOs):

The Undergraduate Curriculum Framework- 2022 (UGCF) is meant to bring about systemic change in the higher education system in the University and align itself with the National Education Policy 2020. The following objectives of NEP are kept in perspective while framing UGCF.

PEO1. To promote each student's holistic development in both academic and non-academic spheres;
PEO2. To provide flexibility to students so that learners have the ability to choose their learning trajectories and programmes, and thereby choose their paths in life according to their talents and interests;
PEO3. To eliminate harmful hierarchies among disciplines/fields of study and silos between different areas of learning; multidisciplinary and holistic education to ensure the unity and integrity of all knowledge;
PEO4. To promote creativity and critical thinking and to encourage logical decision-making and innovation;
PEO5. To promote ethics and human & Constitutional values;
PEO6. To promote multilingualism and the power of language in learning and teaching;
PEO7. To impart life skills such as communication, cooperation, teamwork, and resilience;
PEO8. To promote outstanding research as a corequisite for outstanding education and development.

Programme Outcome (POs):

PO1: Itistogivefoundationknowledgeforthestudentstounderstandbasicsofmathematicsincludingappliedaspectforthesame.
PO2: Itistodevelopeenhancedquantitativeskillsandpursuinghighermathematicsandresearchaswell.
PO3: Studentswillbeabletodevelopsolutionorientedapproachtowardsvariousissuesrelatedtotheirenvironment.
PO4: Studentswillbecomeemployableinvariousgovt.andprivatesectors
PO5: Scientifictemperingeneralandmathematicaltemperinparticularwillbedevelopedinstudents.

Programme Specific Outcome (PSOs):

PSO1: Studentshouldbeabletopossessrecallbasicideaaboutmathematicswhichcanbedisplayedbythem.
PSO2: Studentshouldhaveadequateexposuretomanyaspectsofmathematicalsciences.
PSO3: Studentisequippedwithmathematicalmodelingability,criticalmathematicalthinking,andproblemsolvingskillsetc.
PSO4: Studentshouldbeabletoapplytheirskillsandknowledgeinvariousfieldsofstudiesincluding,science,engineering,commerceandmanagementetc.

SYLLABUS STRUCTURE OVER-All (Based on NEP – 2020)

B.Sc. (Honours/Honours with Research) in Mathematics										
Year	**Semester**	**Nomenclature of the Courses/Title**	**Com/Ele.**	**Credit**	Credit Distribution			Teaching Hours		
					L	T	P	L	T	P
First Year	I	Differential Calculus & Integral Calculus (Major-I)	Compulsory	4	2	0	2	30	0	60
		Introduction to IKS (Major-I)	Compulsory	3	2	1	0	30	15	0
		Minor	Pool Elective	2	2	0	0	30	0	0
		SEC	Pool Elective	3	1	0	2	15	0	60
		VAC	Pool Elective	2	2	0	0	30	0	0
		Other 02 Major	Pool Elective	8	4	0	4	60	0	120
				22				0	0	0
	II	Matrices & Linear Algebra (Major-I)	Compulsory	5	4	1	0	60	15	0
		Minor	Pool Elective	2	2	0	0	30	0	0
		SEC	Pool Elective	3	1	0	0	15	0	0
		VAC	Pool Elective	2	2	0	0	30	0	0
		Other 02 Major	Pool Elective	10	6	0	4	90	0	120
				22						
Exit Option : Certificate in Field of Learning/discipline										
Second Year	III	Differential Equation (Major-I)	Compulsory	4	3	1	0	45	15	0
		Applied IKS-I : Mathematics (Major-I)	Compulsory	3	2	1	0	30	15	0
		Minor Paper for other discipline i. Business Mathematics-I	Pool Elective	2	2	0	0	30	0	0
		SEC	Pool Elective	3	1	0	2	15	0	60
		VAC	Pool Elective	2	2	0	0	30	0	0
		Other 02 Major	Pool Elective	8	4	0	4	60	0	120
				22						
	IV	Geometry & Mathematical Method (Major-I)	Compulsory	5	4	1	0	60	15	0
		Minor Paper for other discipline i. Business Mathematics-II	Pool Elective	2	2	0	0	30	0	0
		SEC	Pool Elective	3	1	0	2	15	0	60
		VAC	Pool Elective	2	2	0	0	30	0	0
		Other 02 Major	Pool Elective	10	6	0	4	90	0	120
				22						
Exit Option : Diploma in Field of Learning/discipline										
Third Year	V	Algebra & Group Theory (Major-I)	Compulsory	4	3	1	0	45	15	0
		Applied IKS-II: Mathematics (Major-I)	Compulsory	3	2	1	0	30	15	0
		Minor	Pool Elective	2	2	0	0	30	0	0

		Note: Choose any one Course 1. Number Theory & Game Theory 2. Graph Theory & Discrete Mathematics 3. Differential Geometry & Tensor Analysis	Elective	3	2	1	0	30	15	0
		VAC	Pool Elective	2	2	0	0	30	0	0
		Other 02 Major	Pool Elective	8	4	0	4	60	0	120
				22						
	VI	Matric Space & Complex Analysis (Major-I)	Compulsory	5	3	0	2	45	0	60
		Note: Choose any one Paper (Major-I) 1. Numerical Analysis 2. Operation Research	Elective	3	2	1	0	30	15	00
		Minor	Pool Elective	2	2	0	0	30	0	0
		VAC	Pool Elective	2	2	0	0	30	0	0
		Internship/Apprenticeship (Major-I)	Compulsory	4	0	0	4	0	0	120
		Other 02 Major	Pool Elective	10	6	0	4	90	0	120
				26						
Exit Option : Basic UG degree in Field of Learning/discipline										
Fourth Year	VII	Topology (Major-I)	Compulsory	6	5	1	0	75	15	0
		2. Research Methodology (Hons. with Research) /Alternate Paper (Honours)	Compulsory	4	4	0	0	60	0	0
		Note: Choose any Two Course (4+4) 1. Calculus of variation and Integral Equation 2. Function of complex variable 3. Mechanics 4. Mathematical Statistic	Elective	8	6	2	0	90	30	0
		Minor Paper From other discipline : History of Indian Mathematics	Pool Elective	4	3	1	0	45	15	0
				22						
	VIII	Functional Analysis	Compulsory	6	5	1	0	75	15	0
		Note: Choose any two Course: (4+4) 1. Measure Theory 2. Probability Theory 3. Advanced Algebra 4. Optimization Techniques	Elective	8	6	2	0	90	30	0
		Dissertation/Research Project & Viva Voce (Hons. with Research) or	Compursory	8	0	0	8	0	0	240

		Field Visit/Tour based Viva Voce (Honours)								
				22						
Completion : UG (Hons./Hons. with Research) degree in Field of Learning/discipline										
		Total Credits		**180**						

*** SEC : Skill Enhancement Course; VAC: Value Added Course; IKS: Indian Knowledge System**

Department of Mathematics
B.Sc.(Honours/Honours with Research) in Mathematics
SYLLABUS (Based on NEP – 2020)
Session 2023 – 24

YEAR	SEMESTER	PAPER TITLE	Course Code	MAJOR/ MINOR	COM/ EL	(L)	(T)	(P)	TOTAL CREDIT	TEACHING HOURS
1ST	IST	Differential Calculus & Integral Calculus	MAT-23101	Major	COM	02	00	02	04	90 (30 + 60)
		Introduction to IKS	MATIKS-2301	Major	COM	02	01	00	03	45
	IIND	Matrices & Linear Algebra	MAT-23102	Major	COM	04	01	00	05	75 (60 + 15)
2ND	IIIRD	Differential Equation	MAT-23103	Major	COM	03	01	00	04	60 (45 + 15)
		Applied IKS-I	MATIKS-2302	Major	COM	02	01	00	03	45
		Minor Paper for other discipline i. Business Mathematics-I	POOL B	Minor	EL	02	00	00	02	30
	IVTH	Geometry & Mathematical Method	MAT-23104	Major	COM	04	01	00	05	75 (60 + 15)
		Minor Paper for other discipline i. **Business Mathematics-II**	POOL B	Minor	EL	02	00	00	02	30
3RD	VTH	Algebra & Group Theory	MAT-23105	Major	COM	03	01	00	04	60 (45 + 15)
		Applied IKS-2	BOTIKS-2303	Major	COM	02	01	00	03	45
		Minor	POOL B	Minor	ELE	02	00	00	02	30

		Note: Choose any one Course 1. Number Theory & Game Theory 2. Graph Theory & Discrete Mathematics 3. Differential Geometry & Tensor Analysis	MAT-23106	Major	EL	02	01	00	03	45 (30+15) 45
		VAC	POOL D	VAC	EL	02	00	00	02	30
	VITH	Matric Space & Complex Analysis	MAT-23107	Major	COM	03	00	02	05	105 (45 + 60)
		Note: Choose any one Course i. Numerical Analysis ii. Operation Research	MAT-23108A/ MAT23108B	Major	EL	02	01	00	03	45 (30+15)
		Minor	POOL B	Mino r	EL	02	00	00	02	30
		VAC	POOL D	VAC	EL	02	00	00	02	30
		Internship/Apprenticeship	MAT-23109	Major	COM	0	0	04	04	120
4TH	VIITH	Topology	MAT-23110	Major	COM	5	1	0	06	90 (75 + 15)
		1. Research Methodology (Honours with Research)/Alternate (Honours)	MAT-23111A/MAT23111B	Major	COM	04	00	00	04	60

		Note: Choose any Two Course i. Calculus of variation and Integral Equation ii. Function of complex variable iii. Mechanics iv. Mathematical Statistic	MAT23112A/MAT23112B/MAT23112C/ MAT23112D	Major	EL	06	02	00	08	120 (90+30)
		Minor Paper for Other Discipline : History of Indian Mathematics	POOL B	Mino r	EL	03	01	00	04	60 (45+15)
	VIIITH	Functional Analysis	MAT-23113	Major	COM	05	01	00	06	90 (75 + 15)
		Note: Choose any two Courses: i. Measure Theory ii. Probability Theory iii. Advanced Algebra iv. Optimization Techniques	MAT23114A/ MAT23114B/ MAT23114C/ MAT23114D	Major	EL	06	02	00	08	120 (90+30)
		Dissertation/Research Project Viva Voce (Hons. with Research)/Field Visit, Educational Tour based Viva Voce	MAT23115A/MAT23115B	Major	COM	00	00	08	08	240

SEMESTER-I

B.Sc. (Honours/Honours with Research) in Mathematics

Programme: B.Sc. (Honours/Honours with Research) in Mathematics	**Year: B.Sc. I st Year**	**Semester : I**
Pedagogy:		
Course Code: MAT-23101	**Course Title:** Differential Calculus & Integral Calculus	
Course Outcome: After completing this course, the students will be able to -		
CO1: The programme outcome is to give foundation knowledge for the students to understand the basics of mathematics including applied aspect for developingenhanced quantitativeskillsand pursuinghigher mathematics andresearchas well. **CO2:** By the time students complete the course they will have wide ranging application of the subject and have the knowledge of real valued functions such as sequences and series. They will also be able to know about convergence of sequence and series. Also, they have knowledge about curvature, envelope andevolutes andtrace curve inpolar,Cartesianas well asparametriccurves. **CO3:** The main objective of the course is to equip the student with necessary analytic and technical skills. By applying the principles of integral he learns tosolveavarietyof practicalproblemsinscienceandengineering. **CO4:**Thestudentisequippedwithstandardconceptsandtoolsatanintermediatetoadvancelevelthatwillservehimwellto wardstakingmoreadvancelevel courseinmathematics.		
Credit: 2+0+2	**Paper: Core Compulsory**	
Max. Marks: 20+80	**Min Passing Marks: 7+29**	
Total Number of Lectures (Lecture +Tutorials +Practical): 30+0+60		

Unit	**Topics**	**No. of Lectures**
Unit I.	Definition of a sequence, theorems on limits of sequences, bounded and monotonic sequences, Cauchy's convergence criterion, Cauchysequence,limitsuperiorandlimitinferiorofasequence,subsequence,Seriesofnon-negativeterms,convergenceanddivergence,Comparisontests,Cauchy'sintegraltest,Ratiotests,Roottest,Raabe'slogarithmictest,deMorganandBertrand'stests,alternating series,Leibnitz'stheorem,absoluteandconditionalconvergence.	6
Unit II	Limit,continuityanddifferentiabilityoffunctionofsinglevariable,Cauchy'sdefinition,Heine'sdefinition,equivalenceofdefinitionofCauchyandHeine,Uniformcontinuity,Borel'stheorem,boundednesstheorem,Bolzano'stheorem,Intermediate valuetheorem, extremevaluetheorem,Darboux'sintermediatevaluetheoremforderivatives,Chainrule,indeterminateforms.	6
Unit III	Rolle'stheorem,LagrangeandCauchyMeanvaluetheorems,meanvaluetheoremsofhigherorder,Taylor'stheoremwithvariousformsofremainders,Successivedifferentiation,Leibniztheorem,Maclaurin'sandTaylor'sseries, Partialdifferentiation,Euler's theoremon homogeneousfunction. Tangentandnormals,Asymptotes,Curvature,Envelopsandevolutes,Testsforconcavityandconvexity,Pointsofinflexion,Multiple points,Parametricrepresentationofcurvesandtracingofparametriccurves,TracingofcurvesinCartesianandPolarforms.	6
Unit IV	Definiteintegralsaslimitofthesum,Riemannintegral,Integrabilityofcontinuousandmonotonicfunctions,Fundamentaltheoremof integralcalculus,Meanvaluetheoremsofintegralcalculus, Differentiationunderthesignofintegration. Improperintegrals,theirclassificationandconvergence,Comparisontest,μ-test,Abel'stest,Dirichlet'stest,quotienttest,Betaand Gammafunctions.	6
Unit V	Rectification,VolumesandSurfacesofSolidofrevolution,Pappustheorem,Multipleintegrals,changeoforderofdoubleintegration, Dirichlet'stheorem,Liouville'stheoremformultipleintegrals.	6

	VectorDifferentiation,Gradient,DivergenceandCurl,Normalonasurface,DirectionalDerivative,VectorIntegration,Theoremsof Gauss,Green,Stokesandrelatedproblems.	

Suggested Readings:

1. R.G.Bartle&D.R.Sherbert,IntroductiontoRealAnalysis,JohnWiley&Sons
2. T.M.Apostal,CalculusVol.I,JohnWiley&SonsInc.
3. S.BalachandraRao&C.K.Shantha,DifferentialCalculus,NewAgePublication.
4. H.Anton,I.Birensand S.Davis,Calculus,JohnWileyandSons,Inc.,2002.
5. G.B.ThomasandR.L.Finney,Calculus,PearsonEducation,2007.
6. Suggestivedigitalplatformsweblinks:NPTEL/SWAYAM/MOOCS
7. CourseBookspublishedinHindimaybeprescribedbytheUniversities.

SuggestedReadings(IntegralCalculus):

1. T.M.Apostal,CalculusVol.II,JohnWileyPublication.
2. ShantiNarayan&Dr.P.K.Mittal,IntegralCalculus,S. Chand.
3. ErwinKreyszig,AdvancedEngineeringMathematics,JohnWiley&Sons.
4. Suggestivedigitalplatformsweblinks:NPTEL/SWAYAM/MOOCS

CourseBookspublishedinHindimaybeprescribedbytheUniversities.

Course prerequisite: To study this course, the students must have had subject Mathematics in class 12^{th}

Suggested continuous Evaluation methods-

Continuous internal Evaluation shall be based on allotted assignments and class text.

The marks shall be as follows:

Internal examination :10
Assignment/Practical/Project : 5
Attendance/Behaviour : 5

Programme: B..Sc. (Honours/Honours with Research) in Mathematics	**Year: B.Sc. I st Year**	**Semester: II**
Pedagogy:		
Course Code: MAT-23101L	**Course Title: Lab work on MATLAB**	

Course Outcome: After completing this course, the students will be able to -

CO1: Themainobjectiveofthecourseistoequipthestudenttoplotthedifferentgraphandsolvethedifferenttypesofequationsbyplottingthegraphusingdifferent computer softwaresuch asMathematica /MATLAB/Maple /Scilab/Maxima etc.

CO2. Aftercompletionofthiscoursestudentwouldbeabletoknowtheconvergenceofsequencesthroughplotting,verify Bolzano-Weierstrasstheoremthroughplotting thesequence,Cauchy'srootstestbyplottingn^{th}rootsand Ratiotest byplottingtheratioof$n^{th}$and $(n+1)^{th}$ term.

CO3. Studentwould beabletoplotComplexnumbersand theirrepresentations,Operationslikeaddition, subtraction,and Multiplication,Division,ModulusandGraphical representationof polar form.

CO4:Student wouldbe abletoperformfollowingtaskofmatrixasAddition,Multiplication,Inverse,Transpose,Determinant,Rank,Eigenvectors,Eigenvalues,CharacteristicequationandverificationoftheCayley-Hamiltontheorem,Solvingthesystemsoflinearequations.

Credit: 0+0+2	**Paper: Core Compulsory**	
Max. Marks: 20+80	**Min Passing Marks: 7+29**	
Total Number of Lectures (Lecture +Tutorials + Practical): 0+0+60		
Unit:	**Topics**	**Practicals (Hrs.)**
Topics **Practical /LabworktobeperformedinComputer Lab.** ListofthepracticalstobedoneusingMathematica/MATLAB/Maple/Scilab/Maximaetc. 1.Plottingthegraphsofthefollowingfunctions: (i) ax (ii) [x](greatestintegerfunction) (iii) x^{2n};n∈N (iv) x^{2n-1};n∈N (v) $\frac{1}{x^{2n-1}}$;n∈N		60

(vi) $\frac{1}{x^{2n}}; n \in N$ (vii) $\sqrt{ax+b}, \lvert ax+b \rvert, c \pm \lvert ax+b \rvert$ (ix) $\lvert x \rvert, \sin\left(\frac{1}{x}\right), x\sin\frac{1}{x}, e^{x}, e^{-x}$ for $x \neq 0$. $\overline{x}$ $\bar{x}$ $\bar{x}$ (x) $e^{ax+b}, \log(ax+b), \sin(ax+b), \cos(ax+b), \lvert \sin(ax+b) \rvert, \lvert \cos(ax+b) \rvert$. Observeanddiscusstheeffectofchangesintherealconstants aandbonthegraphs. (2) Byplottingthegraphfindthesolutionoftheequation $x=e^{x}, x^{2}+1=e^{x}, 1-x^{2}=e^{x}, x=\log_{10}(x), \cos(x)=x, \sin(x)=x, \cos(y)=\cos(x), \sin(y)=\sin(x)$etc Plottingthegraphsofpolynomialofdegree 2,3,4and5,andtheirfirstandsecond derivatives. (4) Sketchingparametriccurves,e.g.,Trochoid,Cycloid,EpicycloidandHypocycloidetc. (5) TracingofconicinCartesiancoordinates. (6) Graphofcircularandhyperbolicfunctions. (7) Obtainingsurfaceofrevolutionofcurves. (8) Complex numbers and their representations, Operations like addition, Multiplication, Division, Modulus. Graphical representationofpolar form. (9) FindnumbersbetweentworealnumbersandplottingoffiniteandinfinitesubsetofR. (10) Matrix Operations: Addition, Multiplication, Inverse, Transpose, Determinant, Rank, Eigenvectors, Eigenvalues, Characteristicequation and verificationoftheCayley-Hamiltontheorem,solvingthe systems oflinear equations. (11) Studytheconvergenceofsequencesthroughplotting. (12) Verify Bolzano-Weierstrass theorem through plotting of sequences and hence identify convergent subsequences from the plot.(13)Studythe convergence/divergenceofinfiniteseriesbyplottingtheirsequencesofpartial sum. (14) Cauchy'srootstestbyplotting *n*-throots. Ratio testbyplotting theratioof*n*-thand (*n*+1)-thterm.	
Practical Mathematics as suggested in Theory paper	
Suggested continuous Evaluation methods-	
Continuous internal Evaluation shall be based on allotted assignments and class text. The marks shall be as follows: Internal examination :10 Assignment/Practical/Project : 5 Attendance/Behaviour : 5	

Programme: B..Sc. (Honours/Honours with Research) in Mathematics	**Year: B.Sc. 1st Year**	**Semester: Ist**
Pedagogy:		
Course Code: MATIKS-2301	Course/Paper Title:	**Introduction to Indian Knowledge System**
Course Outcomes: After completing this course, the students will be able to -		
CO 1: explain the the foundational Concepts & Principles of IKS.		
CO 2: explain the historical development and evolution of Indian Intellectual traditions.		
CO 3: explain the knowledge key texts, thinkers, and schools of thought within the IKS.		

CO 4: analyze the interdisciplinary nature of Indian knowledge, integrating philosophy, spirituality, science, arts, and literature though the study of IKS.		
CO 5: explain the holistic and multidimensional nature of Indian Thought.		
Credit: 03	Paper (Core Compulsory / Elective): Core Compulsory	
Max. Marks : 20 + 80		
Total Number of Lectures (Lecture – Tutorials – Practical): 3 + 0 + 0		
Units:	Topics	No. of Lectures
I	**Introduction to Indian Knowledge System** • Definition, Concepts and Scope of IKS • IKS based approache on Indian Knowledge System & Role of Guru (teacher) • Understanding the concepts of dharma, karma, and the four purusharthas (goals of life)	09
II	**Vedic Knowledge and Philosophy** • Study of the Vedas, including the Rigveda, Yajurveda, Samaveda, and Atharvaveda • Introduction to Upanishads and their metaphysical and philosophical teachings • Analysis of the six orthodox (astika) schools of Indian philosophy (e.g., Nyaya, Vaisheshika, Yoga, Samkhya, Mimamsa, and Vedanta)	09
III	**Unit 3: Spiritual and Mystical Traditions** • Exploration of Hindu spiritual traditions, including Bhakti, Karma, Jnana, and Raja Yoga • Study of Advaita Vedanta and its nondualistic philosophy • Introduction to other spiritual paths like Tantra and Sufism in the Indian context	09
IV	**Scientific and Technological Advancements** • Examination of ancient Indian contributions to mathematics, astronomy, and medicine • Study of scientific treatises such as Aryabhatiya, Sushruta Samhita, and Charaka Samhita • Exploration of the Indian concept of time, measurement, and cosmology	09
V	**Indian Arts, Literature, and Aesthetics** • Analysis of Indian classical music, dance, and theater traditions • Study of classical Sanskrit literature, including the works of Kalidasa and Valmiki • Understanding the concept of rasa (aesthetic experience) and its manifestations in Indian arts • Modern Interpretation and Contemporary Relevance	09

Suggested Readings:

- "Indian Philosophy: A Very Short Introduction" by Sue Hamilton
- "A History of Indian Philosophy" by Surendranath Dasgupta
- "Indian Philosophy: A Critical Survey" by Chandradhar Sharma
- "India: A History" by John Keay
- "The Wonder That Was India" by A.L. Basham
- "Ancient India" by R.S. Sharma
- "The Oxford History of India" edited by Percival Spear
- "A History of Indian Literature" (multiple volumes) by Sisir Kumar Das
- "Indian English Literature" by M. K. Naik
- "The Norton Anthology of World Literature: India, Pakistan, and Bangladesh" edited by Sarah Lawall
- "Indian Art" by Partha Mitter
- "The Art and Architecture of the Indian Subcontinent" by J.C. Harle

- "Indian Architecture: Buddhist and Hindu Period" by Percy Brown
- "The Crest of the Peacock: Non-European Roots of Mathematics" by George Gheverghese Joseph
- "Indian Science and Technology in the Eighteenth Century" by Dharampal
- "Raga Mala: The Autobiography of Ravi Shankar" by Ravi Shankar
- "The Ragas of North India" by Walter Kaufmann
- "The Complete Book of Ayurvedic Home Remedies" by Vasant Lad
- "Ayurveda: The Science of Self-Healing" by Vasant Lad
- "The Heart of Yoga: Developing a Personal Practice" by T.K.V. Desikachar
- "The Yoga Sutras of Patanjali" translated by Swami Satchidananda

Suggested continuous E-Valuation Methods –

Continuous Internal Evaluation (CIL)

Totalmarksforeachcourseshallbebasedoninternalassessment(20%)andsemester end examination (80%).The internal assessment of 20% shall be distributedasunder:

(i) Internal Class Test – 10%.

(ii) Assignment/Project/Practical – 5%

(iii) Attendance/Behavior – 5%.

Other Courses:

Minor : To be Choosed from POOL B
Skill Enhancement Course (SEC) : To be Choosed from POOL C
Value Added Course : To be Choosed from POOL D

SEMESTER-II

Programme: B..Sc. (Honours/Honours with Research) in Mathematics		**Year: B.Sc. I st Year**	**Semester: II**
Pedagogy:			
Course Code: MAT-23102		**Course Title: Matrices & Linear Algebra**	
Course Outcome: After completing this course, the students will be able to -			
CO1: The subjects of the course are designed in such a way that they focus on developing mathematical skills in algebra, calculus and analysis and give in depth knowledge of geometry, calculus, algebra and other theories. **CO2:** The student will be able to find the rank, eigen values of matrices and study the linear homogeneous and non-homogeneous equations. **CO3:** Liner algebra is a basic course in almost all branches of science. The objective of this course is to introduce a student to the basics of linear algebra and some of its applications.			
Credit: 4+1+0		**Paper: Core Compulsory**	
Max. Marks: 20+80		**Min Passing Marks: 7+29**	
Total Number of Lectures (Lecture +Tutorials +Practical): 60+15+0			
Unit:	**Topics**		**No. of Lectures**
Unit I.	Types of Matrices, Elementary operations on Matrices, Rank of a Matrix, Echelon form of a Matrix, Normal form of a Matrix, InverseofaMatrixbyelementaryoperations,Systemoflinearhomogeneousand non-homogeneousequations,Theoremsonconsistencyofa systemoflinearequations.		12
Unit II	Eigen values, Eigen vectors and characteristic equation of a matrix, Caley-Hamilton theorem and its use in finding inverse of a matrix,.		12
Unit III	Vector spaces, Subspaces, Linear independence and dependence of vectors, Basis and Dimension, Quotient space.		12
Unit IV	Linear transformations, The Algebra of linear transformations, rank nullity theorem, their representation as matrices. Linear functionals, Dual space, Characteristic values, Cayley Hamilton Theorem.		12

Unit V	Inner product spaces and norms, Cauchy-Schwarz inequality, Orthogonal vectors, Ortho normal sets and bases, Bessel's inequality for finite dimensional spaces, Gram-Schmidt orthogonalization process, Bilinear and Quadratic forms.	12

Suggested Readings:

1. StephenH.Friedberg,A.J.Insel&L.E.Spence,LinearAlgebra,Person.
2. Topics in Algebra by I.N. Herstein.
3. Linear Algebra by K. Hoffman and R. Kunze.
4. Suggested digital plateform: NPTEL/SWAYAM/MOOCs.

Course prerequisite: To study this course, the students must have had subject Mathematics in class 12th

Suggested continuous Evaluation methods-

Continuous internal Evaluation shall be based on allotted assignments and class text.

The marks shall be as follows:

Internal examination :10
Assignment/Practical/Project : 5
Attendance/Behaviour : 5

Other Courses:

Minor : To be Choosed from POOL B
Skill Enhancement Course (SEC) : To be Choosed from POOL C
Value Added Course : To be Choosed from POOL D

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EXIT OPTION: **Undergraduate Certificate(in the field of learning/discipline**)for those who exit after the first year (two semesters) of theundergraduateprogramme.(Programmeduration:firstyearortwosemestersoftheundergraduateprogramme)**[NSQF Level 5]**

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SEMESTER-III

Programme: B..Sc. (Honours/Honours with Research) in Mathematics	**Year: B.Sc. II nd Year**	**Semester: III**
Pedagogy:		
Course Code: MAT-23103	**Course Title:** Differential Equation	
Course Outcome: After completing this course, the students will be able to -		

CO1: The objective of this course is to familiarize the students with various methods of solving differential equations, partial differential equations of first order and second order and to have qualitative applications.
CO2:A student doing this course is able to solve differential equations and is able to model problems in nature using ordinary differential equations. After completing this course, a student will be able to take more courses on wave equation, heat equation, diffusion equation, gas dynamics, non linear evolution equation etc. These entire courses are important in engineering and industrial applications for solving boundary value problem.

Credit: 3+1+0	**Paper: Core Compulsory**
Max. Marks: 20+80	**Min Passing Marks: 7+29**

Total Number of Lectures (Lecture +Tutorials +Practical): 45+15+0

Unit:	Topics	No. of Lecture
Unit I.	Formation of differential equations, Geometrical meaning of a differential equation, Equation of first order and first degree, Equation in which the variables are separable, Homogeneous equations, Exact differential equations and equations reducible to the exact form, Linear equations.	9
Unit II	First order higher degree equations solvable for x,y,p, Clairaut's equation and singular solutions, Linear differential equation of order greater than one with constant coefficients, Cauchy-Euler form.	9
Unit III	Linear differential equations of arbitrary orders and their solutions, Euler Cauchy equations. Bessel, Legendre and Hyper geometric functions and their properties, recurrence and generating relations	9
Unit IV	Formation of P.D.E's, first order P.D.E.'s, Classification of first order P.D.E.'s, Complete, general and singular integrals, Lagrange's or quasi-linear equations.	9
Unit V	Integral surfaces through a given curve, Orthogonal surfaces to a given system of surfaces, Characteristic curves.	9

Suggested Readings:

1. B. Rai, D.P. Choudhary& H.J. Freedman, A Course in Differential Equations, Narosa
2. D.A. Murray, Introductory Course in Differential Equations, Orient Longman.
3. N. Sneddon: Elements of Partial Differential Equations, McGraw-Hill Pub., 1957.
4. T. Amaranath: An Elementary Course in Partial Differential Equations, Narosa Pub. 2005.
5. Suggested digital plateform: NPTEL/SWAYAM/MOOCs
6. Course Books published in Hindi may be prescribed by the Universities.

Course prerequisite: To study this course, the students must have had subject Mathematics in class 12^{th}

Suggested continuous Evaluation methods-

Continuous internal Evaluation shall be based on allotted assignments and class text.
The marks shall be as follows:
Internal examination :10
Assignment/Practical/Project : 5
Attendance/Behaviour : 5

Programme: B..Sc. (Honours/Honours with Research) in Mathematics	**Year: Second Year**	**Semester: III**
Pedagogy:		
Course Code: MATIKS-2302	**Course Title: Applied IKS-1 : Foundations of Indian Mathematical Knowledge System**	

Course Outcome: After completing this course, the students will be able to -

CO.1 :
CO. 2 :
CO. 3 :
CO. 4 :
CO. 5.:

Credit: 2+1+0	**Paper: Core Compulsory**	
Max. Marks: 20+80	**Min Passing Marks: 7+29**	

Total Number of Lectures (Lecture +Tutorials +Practical): 30+15+0

Unit:	Topics	Lectures (Hrs.)

Unit 1: Introduction to Indian Knowledge System • Overview of Indian knowledge systems, including Vedas, Upanishads, and Darshanas. • Significance of mathematics in ancient Indian philosophy.	6
Unit 2: Number Systems in Indian Mathematics • Decimal place-value system in ancient India. • Representation of numbers using Katapayadi notation. • Operations and arithmetic rules in Indian number systems.	6
Unit 3: Geometry in Ancient India • Development of geometry in Sulba Sutras. • Concepts of geometric shapes, measurements, and constructions. • Application of geometry in temple architecture and town planning.	6
Unit 4: Algebraic Concepts in Indian Mathematics • Algebraic equations and solutions in Brahmasphutasiddhanta. • Contributions of Indian mathematicians to algebraic techniques. • Application of algebra in solving real-world problems.	6
Unit 5: Trigonometry and Astronomy • Trigonometric functions and their applications in astronomy. • Calculation of planetary positions, eclipses, and celestial events. • Link between trigonometry and architectural design.	6

Suggested Readings:

1. "History of Indian Mathematics" by C. N. Srinivasiengar
   This book provides a comprehensive overview of the development of mathematics in India, from ancient times to the modern era. It covers various aspects of Indian mathematical contributions, including number systems, algebra, geometry, and astronomy.

2. "Indian Mathematics: Engaging with the World from Ancient to Modern Times" by George Gheverghese Joseph
   This book explores the rich history of Indian mathematics and its interactions with other cultures. It discusses topics such as the decimal system, trigonometry, algebra, and the Kerala School's contributions.

3. "The Crest of the Peacock: Non-European Roots of Mathematics" by George Gheverghese Joseph
   While not solely focused on Indian mathematics, this book provides a broader perspective on the mathematical contributions from various cultures, including India. It delves into the mathematical achievements of the Indian subcontinent and their influence on the global mathematical landscape.

4. "Sulba Sutras: The Astronomical Codes of the Vedic Period" by M. D. Srinivas
   This book focuses specifically on the Sulba Sutras, which are ancient Indian texts that deal with geometry, particularly in the context of ritualistic practices. It provides insights into the mathematical knowledge of ancient India and its connection to architecture and religious

ceremonies.

5. "Zero: The Biography of a Dangerous Idea" by Charles Seife
   While not exclusively about Indian mathematics, this book discusses the historical development of the concept of zero and its significance in mathematics. It covers the contributions of Indian mathematicians to the concept of zero and its eventual adoption in global mathematics.

6. "Lilavati of Bhaskaracarya: A Treatise of Mathematics of Vedic Tradition" by K. S. Patwardhan
   This book focuses on "Lilavati," a famous treatise on mathematics written by the Indian mathematician Bhaskaracarya. It covers a wide range of mathematical topics and problems, showcasing the Indian mathematical knowledge system.

7. "Aryabhata's Aryabhatiya" translated by K. S. Shukla
   This book presents the translated text of the Aryabhatiya, a seminal work by the ancient Indian mathematician Aryabhata. It provides insights into various mathematical concepts and astronomy in ancient India.

8. "Mathematics in India" by T. A. Sarasvati Amma
   This book offers an overview of Indian mathematical traditions, including discussions on number theory, algebra, geometry, and trigonometry. It also provides insights into the contributions of Indian mathematicians over different periods.

Course prerequisite: To study this course, the students must have had subject biology in class 12th

Suggested continuous Evaluation methods-

Continuous internal Evaluation shall be based on allotted assignments and class text.
The marks shall be as follows:
Internal examination :10
Assignment/Practical/Project : 5
Attendance/Behaviour : 5

MINOR PAPER for Other Discipline

Programme: B..Sc. (Honours/Honours with Research) in MAthematics	**Year: B.Sc. IInd Year**	**Semester: III**
Pedagogy:		
Course Code: POOL B	**Course Title: Business Mathematics-I**	

Course Outcome: After completing this course, the students will be able to -

CO.1. Apply sets, relations, functions in business.
CO.2. Use permutations and combinations.
CO.3. Use matrices in commercial fields.
CO.4. Apply trigonometric function real world

Credit: 2+0+0	**Paper: Elective (Minor)**
Max. Marks: 20+80	**Min Passing Marks: 7+29**

Total Number of Lectures (Lecture +Tutorials + Practical): 30+0+0

Unit	**Topics**	**No. of Lecture**
Unit I	Algebra-Sets, relation, function, indices, logarithms, permutation and combination,Examples on commercial mathematics.	6
Unit II	Matrices-Definition of matrix; type of matrices; Algebra of matrices,Determinants, Properties of determinants, Calculation of values of determinants of to third order, Adjoint of a matrix, Elementary row and column operations.	8
Unit III	Linear algebra-Solution of a system of linear equation involving not more than three variables, Examples on commercial mathematics.	8
Unit IV	Trigonometric Function-Recapitulation of basics definitions	8

	of trigonometric functions, Signs of trigonometric functions and sketch of their graphs. Trigonometric function of sum difference of two angles. Trigonometric ratios.	

Suggested Readings:

1. 1. Allel R.G.A : Basics Mathematics: Macmilan, New Delhi.
2. Dowling, E.T. Mathematics For Economics : Schaum Series, McGraw Hill, London.
3. Soni R.S.: Business Mathematics: Pitamber Publishing House , Delhi.
4. N. Rudraiah anand others: College Mathematics for B.Sc. Series 1 and 11. SBS zublication Co

Course. prerequisite: To study this course, the students must have had subject Mathematics in class 12th

Suggested continuous Evaluation methods-

Continuous internal Evaluation shall be based on allotted assignments and class text.

The marks shall be as follows:

Internal examination :10
Assignment/Practical/Project : 5
Attendance/Behaviour : 5

Other Courses:

Minor : To be Choosed from POOL B

Skill Enhancement Course (SEC) : To be Choosed from POOL C

Value Added Course : To be Choosed from POOL D

SEMESTER-IV

Programme: B.Sc. (Honours/Honours with Research) in Mathematics	**Year: B.Sc. IInd Year**	**Semester: IV**
Pedagogy:		
Course Code: MAT-23104	**Course Title:** Geometry & Mathematical Methods	
Course Outcome: After completing this course, the students will be able to -		
CO1: The subjects learn and visualize the fundamental ideas about coordinate geometry and learn to describe some of the surface by using analytical geometry. **CO2:** On successful completion of the course students should have knowledge about higher different mathematical methods and will help him in going for higher studies and research.		
Credit: 4+1+0	**Paper: Core Compulsory**	
Max. Marks: 20+80	**Min Passing Marks: 7+29**	
Total Number of Lectures (Lecture +Tutorials + Practical): 60+15+0		

Unit	**Topics**	**No. of Lecture**
Unit I	General equation of second degree, System of conics, Tracing of conics, confocal conics, Polar equation of conics and its properties, Three-Dimensional Coordinates, Projection and Direction Cosine, Plane(Cartesian and vector form), Straight line in three dimension.	12
Unit II	Sphere, Cone and Cylinder, Central conicoids, Paraboloids, Plane section of conicoids, Generating lines, Confocal conicoids, Reduction of second degree equations.	12
Unit III	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
Unit IV	Existence theorems for Laplace transforms, Linearity of Laplace transform and their properties, Laplace transform of the derivatives and integral of a function, Convolution theorem, inverse Laplace transforms, Solution of the differential equations using Laplace transforms.	12
Unit V	Fourier series, Fourier expansion of piece wise monotonic functions, Half and full range expansions, Fourier transforms (finite and infinite), Fourier integral.	12

SuggestedReadings (Geometry):

1. Robert J.T. Bell, Elementary Treatise on Coordinate Geometry of three dimensions, Macmillan India Ltd.
2. P.R. Vittal, Analytical Geometry 2d & 3D, Pearson.
3. S.L .Loney, The Elements of Coordinate Geometry, McMillan and Company, London.
4. R. J. T. Bill, Elementary Treatise on Coordinate Geometry of Three Dimensions, McMillan India Ltd., 1994.
5. Suggested digital plateform: NPTEL/SWAYAM/MOOCs

SuggestedReadings(Mathematical Method)

1. T.M. Apostal, Mathematical Analysis, Person
2. G.F. Simmons, Differential Equations with Application and Historical Notes, Tata-Mc Graw Hill
3. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons.
4. Suggested digital plateform: NPTEL/SWAYAM/MOOCs

CourseBookspublishedinHindimaybeprescribedbytheUniversities.

Course prerequisite: To study this course, the students must have had subject Mathematics in class 12th

Suggested continuous Evaluation methods-

Continuous internal Evaluation shall be based on allotted assignments and class text.
The marks shall be as follows:
Internal examination :10
Assignment/Practical/Project : 5
Attendance/Behaviour : 5

Minor Paper for other Discipline

Programme: B.Sc. (Honours/Honours with Research) in Mathematics	**Year: B.Sc. II nd Year**	**Semester: IV**
Pedagogy:		
Course Code: POOL B	**Course Title: Business Mathematics-II**	
Course Outcome: After completing this course, the students will be able to -		
CO1: Integrated concept in international business concept with functioning of global trade **CO2:** Apply decision-support tools to business decision making.		
Credit: 2+0+0	**Paper (Code compulsory/Elective): Core**	
Max. Marks: 20+80	**Min Passing Marks: 7+29**	
Total Number of Lectures (Lecture +Tutorials + Practical): 30+0+0		

Unit	**Topics**	**No. of Lecture**
Unit I	Interest: Concept of Present value and future value, simple interest, compound intereset, Nomial and effective rate of interest, examples and problems.	8
Unit II	Annuity: Ordinary Annuity, Sinking Fund, Annuity due, present value and Future value of annuity, equated monthly installments by interest of reducing balance and flat interest methods, examples and problem.	10
Unit III	Frequency distribution: Raw data, attributes and variables, classification of data, frequency distribution, cumulative frequency distribution, histogram and ogive curve, requisites of idel measure of central tendency.	8
Unit IV	Arithmetic means, median, and mode for ungrouped and grouped data, combined means merits and demerits of measure of central tendency, Geometric means: definition, merits and demerits, Harmonics mean: definition, merits and demerits	4

SuggestedReadings

1. R.G.Bartle&D.R.Sherbert,IntroductiontoRealAnalysis,JohnWiley&Sons
2. T.M.Apostal,CalculusVol.I,JohnWiley&SonsInc.
3. S.Bala ChandraRao&C.K.Shantha,DifferentialCalculus,NewAgePublication.
4. H.Anton,I.Birensand S.Davis,Calculus,JohnWileyandSons,Inc.,2002.
5. G.B.ThomasandR.L.Finney,Calculus,PearsonEducation,2007.
6. Suggestivedigitalplatformsweblinks:NPTEL/SWAYAM/MOOCS

Course. prerequisite: To study this course, the students must have had subject Mathematics in class 12th

Suggested continuous Evaluation methods-
Continuous internal Evaluation shall be based on allotted assignments and class text. The marks shall be as follows: Internal examination :10 Assignment/practical/project : 5 Attendance/behaviour : 5

Other Courses:

Minor : To be Choosed from POOL B
Skill Enhancement Course (SEC) : To be Choosed from POOL C
Value Added Course : To be Choosed from POOL D

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Exit Option: **UndergraduateDiploma**(inthefieldoflearning/discipline)for those who exit after two years (four semesters) of theundergraduateprogramme(Programmeduration:Firsttwoyearsorfoursemestersoftheundergraduateprogramme)**[NSQF Level 6]**

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SEMESTER-V

Programme: B.Sc. (Honours/Honours with Research) in Mathematics	**Year: B.Sc. IIIrd Year**	**Semester: V**
Pedagogy:		
Course Code: MAT-23105	**Course Title**: Algebra & Group Theory	
Course Outcome: After completing this course, the students will be able to -		
CO1: Group is a basic course in almost all branches of science. The objective of this course is to introduce a student to the basics of algebra and someof itsapplications. **CO2:**Students will be able to know the concepts of group, ring and other related properties which will prepare the students to take up further applications intherelevantfields.		
Credit: 03+1+0	**Paper : Core Compulsory**	
Max. Marks: 20+80	**Min Passing Marks: 7+29**	
Total Number of Lectures (Lecture +Tutorials + Practical): 45+15+0		

Unit	Topic	No. of Lecture
Unit I	Definition of a Group with examples and simple properties, Subgroups, Cyclic groups, Coset decomposition, Lagrange's Theorem, and its consequences, Fermat's and Euler's theorems	9
Unit II	Homomorphism and isomorphism, Properties and examples, Normal subgroups, quotient groups, the fundamental theorems of Homomorphism.	9
Unit III	Permutation Groups, cycle decomposition, Even and odd permutations, the alternative group A_n, Cayley's theorem	9
Unit IV	Rings, Subrings, Ideals and quotient rings, Ring homomorphism, Integral domains and fields, Field of quotient of an Integral domain.	9
Unit V	Polynomial Rings over a Field, Division and Euclidean algorithms for Polynomials, Remainder & Factor Theorems, Reducibility tests, Irreducibility tests Eisenstein criterion, Unique factorization in Z[x].	9

Suggested Readings:

1. 1. Ramji Lal, Algebra (Vol.I), Shail Publication, Allahabad.
2. Ramji Lal, Algebra (Vol. II), Shail Publication, Allahabad.
2. Dummit Foote, Abstract Algebra, Wiley & Sons, Inc., New York.
4. R. S. Mishra and N. N. Bhattacharya, Fundamental Structures in Modern Algebra, Pothishala Pvt. Ltd. Allahabad.
5. Joseph A. Gallian, Contemporary Abstract Algebra, Narosa Publishing House.

Course prerequisite: To study this course, the students must have had subject Mathematics in class 12th
Suggested continuous Evaluation methods-
Continuous internal Evaluation shall be based on allotted assignments and class text. The marks shall be as follows: Internal examination :10 Assignment/Practical/Project : 5 Attendance/Behaviour : 5

Programme: B..Sc. (Honours/Honours with Research) in Mathematics	**Year: Third Year**	**Semester: V**
Pedagogy:		
Course Code: MATIKS-2303	**Course Title: Applied IKS-2 : Advanced Topics in Indian Mathematical Knowledge System**	
Course Outcome: After completing this course, the students will be able to -		
CO.1 CO. 2 CO. 3 CO. 4 CO. 5.		
Credit: 2+1+0	**Paper: Core Compulsory**	
Max. Marks: 20+80	**Min Passing Marks: 7+29**	
Total Number of Lectures (Lecture +Tutorials +Practical): 30+15+0		
Unit:	**Topics**	**Lectures (Hrs.)**
Unit-1: Kerala School of Mathematics • Overview of the Kerala School of Mathematics. • Contributions of Madhava, Neelakantha, and Jyeshtadeva. • Calculus-like techniques in the works of Kerala mathematicians.		06
Unit-2: Infinite Series and Approximations • Madhava series and their significance. • Calculation of π (pi) and other mathematical constants. • Connection between infinite series and modern calculus.		06
Unit-3: Zero and Infinity in Indian Mathematics • Historical development of the concept of zero in Indian mathematics. • Philosophical implications of zero and infinity. • Use of zero and infinity in calculations and proofs.		06
Unit-4: Sankhya and Mathematics • Exploration of the concept of numbers and counting in Indian philosophy. • Nyaya and Vaisheshika perspectives on mathematics. • Relationship between abstract mathematical concepts and philosophical thought.		06

Unit-5: Applications in Contemporary Contexts • Modern applications of Indian mathematical concepts. • Comparative analysis of Indian and Western mathematical traditions. • Potential for integrating Indian knowledge systems into current mathematics education.	06

Suggested Readings:

1. "A History of Indian Literature: Scientific and Technical Literature" by Subhash Kak
   This book delves into the scientific and technical literature of ancient India, including mathematics. It explores the contributions of the Kerala School of Mathematics and other Indian mathematicians to advanced topics such as calculus and infinite series.

2. "Kerala Mathematics: History and Its Possible Transmission to Europe" by George Gheverghese Joseph
   This book focuses specifically on the contributions of the Kerala School of Mathematics, including its work on calculus and infinite series. It discusses the possible transmission of these ideas to Europe and their impact on the development of modern mathematics.

3. "Classical Indian Metaphysics: Refutations of Realism and the Emergence of "New Logic" by Kisor Kumar Chakrabarti
   While not a mathematics-focused book, this work explores the development of logic and metaphysics in ancient India. It provides insights into the philosophical context that influenced mathematical thinking and the emergence of new concepts.

4. "Indian Mathematics and Astronomy: Some Landmarks" by S. Balachandra Rao
   This book covers a range of advanced topics in Indian mathematics and astronomy. It includes discussions on the works of notable Indian mathematicians and their contributions to areas like calculus, trigonometry, and astronomy.

5. "The Āryabhaṭīya of Āryabhaṭa: An Ancient Indian Work on Mathematics and Astronomy" by K. S. Shukla
   This book provides a translation and analysis of the Āryabhaṭīya, a significant work by the ancient Indian mathematician Āryabhaṭa. It covers advanced mathematical concepts and their applications in astronomy.

6. "The Exact Sciences in Antiquity" by O. Neugebauer
   While not solely focused on Indian mathematics, this classic work provides a broader perspective on the history of mathematics in various ancient civilizations, including India. It includes discussions on advanced mathematical concepts and their development.

7. "Yuktibhāṣā: The Most Significant Commentary on the Gaṇita Section of the Tantrasamgraha" by S. Balachandra Rao
   This book explores the Yuktibhāṣā, a commentary on the Gaṇita (mathematics) section of the Tantrasamgraha. It covers advanced topics in Indian mathematics and provides insights into mathematical methods and applications.

8. "Indian Mathematics: Culture and Continuity" by Kim Plofker
   This book covers a wide range of topics in Indian mathematics, including advanced concepts and their historical development. It offers a comprehensive view of the mathematical traditions of India.

Course prerequisite: To study this course, the students must have had subject Mathematics in class 12^{th}

Suggested continuous Evaluation methods-

- Quizzes and assignments on historical developments and concepts.
- In-class discussions and presentations on the practical applications of Indian mathematical knowledge.

- Research projects exploring the influence of Indian mathematical ideas in various fields.
- Final exam covering both theoretical understanding and practical applications.

Continuous internal Evaluation shall be based on allotted assignments and class text.
The marks shall be as follows:
Internal examination :10
Assignment/Practical/Project : 5
Attendance/Behaviour : 5

Major (Elective): Choose Any One Course

Programme: B..Sc. (Honours/Honours with Research) in Mathematics	**Year: Third Year**	**Semester: V-VI**
Pedagogy		
Course Code: MAT-23106A	**Course Title: Number Theory & Game Theory**	

Course Outcome: After completing this course, the students will be able to -

CO1: Upon successful completion, students will have the knowledge and skill to solve problems in elementary number theory and also apply elementary
Number theory to cryptography.
CO2: This course provides an introduction to Game Theory. Game Theory is a mathematical framework which makes possible the analysis of the decision making process of interdependent subjects. It is aimed at explaining and predicting how individuals behave in a specific strategic situation, and therefore help improve decision making.

Credit: 2+1+0	**Paper: Elective (Major)**
Max. Marks: 20+80	**Min Passing Marks: 7+29**

Total Number of Lectures (Lecture +Tutorials + Practical): 30+15+0

Unit	**Topics**	**No. of Lecture**
Unit I	Divisibility;Euclideanalgorithm;primes;congruences;Fermat'stheorem,Euler'stheoremandWilson'stheorem;Fermat'squotientsand theirelementaryconsequences;solutionsofcongruences;Chineseremaindertheorem; Euler's phi-function.	6
Unit II	Congruencemodulopowersofprime;primitiverootsandtheirexistence;quadraticresidues;Legendresymbol,Gauss'lemmaaboutLegendresymbol;quadratic reciprocitylaw;proofsof various formulations;Jacobi symbol.	6
Unit III	Introduction,characteristicofgametheory,Two-personzero-sumgame,PureandMixedstrategies,Saddlepointanditsexistence.	6
Unit IV	Relationship betweenrectangulargameandLinear ProgrammingProblem,Solvingrectangular gameby Simplexmethod,	6
Unit V	FundamentalTheoremofRectangulargames,ConceptofDominance,DominanceandGraphicalmethodofsolvingRectangulargames.	6

Suggested Readings(Number Theory):

1. Niven, I. ,Zuckerman ,H.S. and Montegomery, H. L.(2003)An Int. to the Theory of Numbers (6thedition)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)IntroductoryDiscreteMathematics,DoverPublications.
5. Suggested digital plateform: NPTEL/SWAYAM/MOOCs

Suggested Readings(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, (Website1) http://www.ece.stevens-tech.edu/~ccomanic/ee800c.html
5. Allan Mac Kenzie, Game Theory for Wireless Engineers, Synthesis lectures on Communications, 2006

Suggested digital plateform: NPTEL/SWAYAM/MOOCS

Course. prerequisite: To study this course, the students must have had subject Mathematics in class 12th

Suggested continuous Evaluation methods-
Continuous internal Evaluation shall be based on allotted assignments and class text. The marks shall be as follows: Internal examination :10 Assignment/Practical/Project : 5 Attendance/Behaviour : 5

Or

Programme: B..Sc. (Honours/Honours with Research) in Mathematics	**Year: Third Year**	**Semester: V**
Pedagogy:		
Course Code: MAT-23106B	**Course Title: Graph Theory & Discrete Mathematics**	
Course Outcome: After completing this course, the students will be able to -		
CO1: After Successful completion of this course students will be able to understand the isomorphism and homomorphism of graphs. This course covers the basic concepts of graphs used in computer science and other disciplines. The topics include path, circuits, adjacency matrix, tree, coloring.. After successful completion of this course the student will have the knowledge graph coloring, color problem, vertex coloring. **CO2:** This course covers the basic concepts of discrete mathematics used in computer science and other disciplines that involve formal reasoning. The topics include logic, counting, relations, has diagram and Boolean algebra. After successful completion of this course the student will have the knowledge in Mathematical reasoning, combinatorial analysis, discrete structures and Applications.		
Credit: 2+1+0	**Paper: Elective (Major)**	
Max. Marks: 20+80	**Min Passing Marks: 7+29**	
Total Number of Lectures (Lecture +Tutorials + Practical): 30+15+0		

Unit	**Topics**	**No. of Lecture**
Unit I	Introductiontographs,basicpropertiesof graphs,Simplegraph,multigraph,graphterminology,representationofgraphs,Bipartite,regular,planarandconnectedgraphs,connectedcomponentsinagraph,Eulergraphs, Directed,Undirected,multi-graph,mixedgraph.	8
Unit II	Operationofgraphcircuit,Pathand circuits,Euleriancircuits, Tree,BinaryandSpanningtrees,Coloring,Colorproblems,Vertexcoloringandimportantproperties.	10
Unit III	Mathematical Logic Statements, Truth value of a statement, Logical connectives, Conjunction, Disjunction and Negation operations, Conditional and Biconditional join, Propositional functions, Tautologies and contradictions, Law of duality, Quantifiers.	8
Unit IV	Boolean algebra, Principle of Duality, Switching Circuits, Logic Circuits OR Gate, AND gate, Logic Networks.	4

Suggested Readings (Graph Theory)

1. "Graph Theory with Applications to Engineering and Computer Science" by Nar Singh Deo
2. "Introduction to Graph Theory" by Douglas B West
3. "Graph Theory with AlgorithmsandItsApplications:InAppliedScienceandTechnology"bySantanuSahaRay

Suggested Readings (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 plate form: NPTEL/SWAYAM/MOOCS.

Course Books published in Hindi may be prescribed by the Universities

Course. prerequisite: To study this course, the students must have had subject Mathematics in class 12th

Suggested continuous Evaluation methods-
Continuous internal Evaluation shall be based on allotted assignments and class text. The marks shall be as follows: Internal examination :10 Assignment/Practical/Project : 5 Attendance/Behaviour : 5

Or

Programme: B..Sc. (Honours/Honours with Research) in Mathematics	**Year: Third Year**	**Semester: V**
Pedagogy:		
Course Code: MAT-23106C	**Course Title: Differential Geometry & Tensor Analysis**	

Course Outcome: After completing this course, the students will be able to -

CO1: determine and calculate curvature of curves in different coordinate systems.
CO2: This course covers the Local theory of Curves, Local theory of surfaces, Geodesics, Geodesics curvature, Geodesic polars, Curvature of curves on surfaces, Gaussian curvature, Normal curvature etc.
CO3: understand tensor algebra, different types of tensors, Riemannian space, Ricci tensor, Einstein space and Einstein tensor etc.

Credit: 2+1+0	**Paper: Elective (Major)**
Max. Marks: 20+80	**Min Passing Marks: 7+29**

Total Number of Lectures (Lecture +Tutorials + Practical): 30+15+0

Unit	**Topics**	**No. of Lecture**
Unit 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.	8
Unit II	Local Theory of Surfaces-Parametric patches on surface curve of a surface, family of surfaces(one parameter), edge of regression, ruled surfaces, skew ruled surfaces and developable surfaces ,surfaces of revolution, Helicoids.	10
Unit III	Tensor algebra: Vector spaces, the dual spaces, tensor product of vector spaces, transformation formulae, contraction, special tensors-Symmetric tensor, inner product, associated tensor with examples.	8
Unit IV	Tensor Analysis: Contravariant and covariant vector and tensors, Mixed tensors, Symmetric and skew-symmetric tensors, Algebra of tensors, Contraction and inner product, Quotient theorem, Reciprocal tensors, Christoffel's symbols, Law of transformation of Christoffel's symbols, Covariant differentiation, non-commutativity of Covariant derivative.	4

Suggested Readings (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. Sokolnik off, John Wiley and Sons.,1964.

Suggested digital plateform: NPTEL/SWAYAM/MOOCs

Suggested Readings (Tensor Analysis):

1. Tensors-Mathematics of Differential GeometrybyZ.Ahsan,PHI,2015
2. David C. Kay, Tensor Analysis, Schaum's OutlineSeries, Mc Graw Hill 1988.
3. R.S, Mishra, A Course in Tensors with Applications to Reimannian Geometry, Pothishala Pvt .Ltd, Allahabad.

Suggested digital plateform: NPTEL/SWAYAM/MOOCS

Course. prerequisite: To study this course, the students must have had subject Mathematics in class 12th

Suggested continuous Evaluation methods-

Continuous internal Evaluation shall be based on allotted assignments and class text.
The marks shall be as follows:
Internal examination :10
Assignment/Practical/Project : 5
Attendance/Behaviour : 5

Other Courses:

Minor : To be Choosed from POOL B
Value Added Course : To be Choosed from POOL D

SEMESTER-VI

Programme: B..Sc. (Honours/Honours with Research) in Mathematics	**Year: B.Sc. IIIrd Year**	**Semester: VI**
Pedagogy:		
Course Code: MAT-23107	**Course Title:** Matric Space & Complex Analysis	

Course Outcome: After completing this course, the students will be able to -

CO1: foundations of analysis which will be useful in understanding various physical phenomena and gives the student the foundation in mathematics.
CO2: rigorous and deeper understanding of fundamental concepts in Mathematics. This will be helpful to the student in understanding pure mathematics and in research.
CO3: know the concepts of metric space, basic concepts and developments of complex analysis which will prepare the students to take up further applications in the relevant fields.

Credit: 3+0+2	**Paper: Core Compulsory**
Max. Marks: 20+80	**Min Passing Marks: 7+29**

Total Number of Lectures (Lecture +Tutorials + Practical): 45+0+60

Unit	**Topics**	**No. of Lecture**
Unit I	Metric spaces**:** Definition and examples, Sequences in metric spaces, Cauchy sequences, Complete metric space, Open and closed ball, Neighbourhood, Open set, Interior of a set, limit point of a set, derived set, closed set, closure of a set, diameter of a set, Cantor's theorem, Subspaces, Dense set.	10
Unit II	Continuous mappings, Sequential criterion and other characterizations of continuity, Uniform continuity, Homeomorphism, Contraction mapping, Banach fixed point theorem.	10
Unit III	Functions of complex variable, Mappings; mappings by the exponential function, Limits, Theorems on limits, Limits involving the point at infinity, Continuity.	10
Unit IV	Derivatives, Differentiation formulae, Cauchy-Riemann equations, sufficient conditions for differentiability; Analytic functions and their examples.	8
Unit V	Exponential function, Logarithmic function, Branches and derivatives of logarithms, Trigonometric function, Derivatives of functions, Definite integrals of functions, Contours, Contour integrals and its examples.	7

Suggested Readings: (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 (2nded.). Narosa Publishing House. NewDelhi.
4. Simmons, G.F.(2004). Introduction to Topology and Modern Analysis. Tata Mc Graw Hill. NewDelhi.
5. Suggested digital plate form :NPTEL/SWAYAM/MOOCS.

Suggested Readings(Complex Analysis):

1. Function of Complex Variable by Shanti Narain.
2. Complex variable and applications by Brown & Churchill.
3. Suggested digital plate form: NPTEL/SWAYAM/MOOCS.

Course prerequisite: To study this course, the students must have had subject Mathematics in class 12th

Suggested continuous Evaluation methods-

Continuous internal Evaluation shall be based on allotted assignments and class text.
The marks shall be as follows:
Internal examination :10
Assignment/Practical/Project : 5
Attendance/Behaviour : 5

MAJOR Elective: Choose any one Course

Programme: B..Sc. (Honours/Honours with Research) in Mathematics	**Year: B.Sc. IIIrd Year**	**Semester: VI**
Pedagogy:		
Course Code: MAT-23108A	**Course Title: Numerical Analysis**	

Course Outcome: After completing this course, the students will be able to -

By the end of the course, students should be able to:

CO1. Understand Numerical Methods: Gain a solid understanding of the fundamental concepts, principles, and techniques of numerical analysis, including approximation, interpolation, integration, and solving equations.

CO2. Apply Numerical Techniques: Apply various numerical methods to solve mathematical problems across different disciplines, such as engineering, physics, economics, and computer science.

CO3. Solve Equations: Apply iterative methods (e.g., Newton-Raphson, bisection, secant) to find solutions of nonlinear equations, and understand when and how to choose appropriate methods.

CO4. Interpolate and Extrapolate Data: Use interpolation techniques (e.g., Lagrange, Newton, spline) to estimate values within a given set of data points, and extrapolate to predict values outside the data range.

CO5. Perform Numerical Integration: Apply numerical integration techniques (e.g., trapezoidal rule, Simpson's rule) to approximate definite integrals of functions, and assess the accuracy of these approximations.

Credit: 2+1+0	**Paper: Core Compulsory**
Max. Marks: 20+80	**Min Passing Marks: 7+29**

Total Number of Lectures (Lecture+Tutorials+Practical): 30+15+0

Unit:	**Topics**	**No. of Lectures (Hrs.)**
I	**Introduction to Numerical Analysis and Error Analysis** • Overview of numerical analysis and its applications. • Sources of errors in numerical computations: round-off and truncation errors. • Floating-point representation and machine epsilon.	6
II	**Interpolation and Polynomial Approximation:** • Polynomial interpolation: Lagrange and Newton methods. • Error analysis in interpolation. • Application of interpolation in data fitting.	6
III	**Numerical Differentiation, Integration, and Solving Equations** • Numerical differentiation using finite difference approximations. • Numerical integration techniques: trapezoidal rule, Simpson's rule. • Solving nonlinear equations: bisection, fixed-point iteration.	6
IV	**Linear Systems of Equations and Ordinary Differential Equations** • Gaussian elimination and LU factorization for linear systems. • Introduction to numerical solutions of ordinary differential equations. • Euler's method and Runge-Kutta methods for first-order ODEs.	6
V	**Advanced Topics and Applications** • Introduction to optimization techniques. • Brief overview of numerical linear algebra. • Discussion of real-world applications and potential further study areas.	6

Suggested Readings: (Numerical Analysis)

1. S. S. Sastry, Introductory Methods of Numerical Analysis, PHI.
2. M. K. Jain, S.R.K. Iyengar& R. K. Jain, Numerical Methods for Scientific and Engineering Computation
3. K. Sankara Rao, Numerical Method for Scientist & Engineers.
4. E. Kreyszig, Advanced Engineering Mathematics.

Course prerequisite: To study this course, the students must have had subject Mathematics in class 12th

Suggested continuous Evaluation methods-

Continuous internal Evaluation shall be based on allotted assignments and class text.

The marks shall be as follows:

Internal examination :10
Assignment/Practical/Project : 5
Attendance/Behaviour : 5

Or

Programme: B..Sc. (Honours/Honours with Research) in Mathematics	**Year: Third Year**	**Semester: V-VI**
Pedagogy:		
Course Code: MAT-23108B	**Course Title: Operation Research**	
Course Outcome: After completing this course, the students will be able to -		
CO.1 The student will be able to solve various problems based on convex sets and linear programming. After successful completion of this paper will enable the students to apply the basic concepts of transportation problems and its related problems to apply in further concepts and application of operations research.		
Credit: 2+1+0	**Paper: Elective (Major)**	
Max. Marks: 20+80	**Min Passing Marks: 7+29**	
Total Number of Lectures (Lecture +Tutorials + Practical): 30+15+0		

Unit	Topics	No. of Lecture
Unit I	**Introduction to Operations Research** • Definition and scope of operations research. • Historical development and applications in decision-making. • Formulation of optimization problems: linear and nonlinear programming.	6
Unit II	**Linear Programming and Simplex Method** • Formulation of linear programming (LP) problems. • Graphical solution and introduction to the simplex method. • Implementation of the simplex algorithm. • Sensitivity analysis and interpretation of results.	6
Unit III	**Integer Programming and Network Optimization** • Introduction to integer programming (IP) problems. • Formulation of IP problems and applications. • Network optimization: shortest path, minimum spanning tree, and maximum flow problems.	6
Unit IV	**Nonlinear Programming and Dynamic Programming** • Basics of nonlinear programming (NLP) problems. • Unconstrained optimization and gradient-based methods. • Introduction to dynamic programming and applications. • Solving dynamic programming problems using recursion and memoization.	6
Unit V	**Heuristic Methods and Applications** Introduction to heuristic and metaheuristic methods. Overview of simulated annealing, genetic algorithms, and particle swarm optimization. Application of operations research in real-world scenarios. Discussion of ethical considerations in decision-making.	6

Suggested Readings(Operations Research)

1. H. A. Taha, Operations Research: An Introduction.
2. P. K. Gupta and D. S. Hira, Operations Research.
3. G. Srinivasan, Operations Research Principle & Applications.
4. S.R. Yadav & A.K. Malik, Operation Research, Oxford University Press.

Course. prerequisite: To study this course, the students must have had subject Mathematics in class 12^{th}

Suggested continuous Evaluation methods-

Continuous internal Evaluation shall be based on allotted assignments and class text. The marks shall be as follows: Internal examination :10 Assignment/Practical/Project : 5 Attendance/Behaviour : 5

Other Courses to Opt:

Internship/Apprenticeship (Compulsory)

Minor : To be Choosed from POOL B
Value Added Course : To be Choosed from POOL D

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Exit Option:Bachelor'Degree(Programmeduration:Threeyearsorsixsemesters).

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SEMESTER-VII

Programme: B..Sc. (Honours/Honours with Research) in Mathematics	**Year: B.Sc. IVth Year**	**Semester: VII**
Pedagogy:		
Course Code: MAT-23110	**Course Title:** Topology	
Course Outcome: After completing this course, the students will be able to -		
CO.1 understand the topology space. **CO.2**. understand the application of T_0, T_1, T_2, T_3 etc. **CO.3.** know about the property of compactness and connectedness. **CO.4.** know about the Product topology and Countability properties		
Credit: 5+1+0	**Paper (Code compulsory/Elective): Core Compulsory**	
Max. Marks: 20+80	**Min Passing Marks: 7+29**	
Total Number of Lectures (Lecture +Tutorials + Practical): 75+15+0		

Unit	Topics	No. of Lecture
Unit I	Definition and examples of topological spaces (including metric spaces). Open and closed sets, Subspaces and relative topology. Closure and interior, Accumulation points and derived sets, Dense sets Neighbourhoods, Boundary, Bases and sub-bases. Homeomorphism, First and second Countability and separable space, Lindelof space.	15
Unit II	The separation axioms T_0, T_1, T_2 T_3, $T_{3(1/2)}$ and T_4, their characterizations and basic properties, Urysohn's lemma, and Teitze extension theorem.	15
Unit III	Compactness, Basic properties of compactness the finite intersection property; local compactness, One-point compactification.	15
Unit IV	Connected spaces and their basic properties, Connectedness of the real line, Components, Locally connected spaces.	15
Unit V	Product topology in terms of the standard sub-base and its characterizations, Product topology and separation axioms, connectedness. Countability properties and compactness.	15

Suggested Readings:

1. J.L. Kelley, General Topology, Van Nostr and,1995.
2. K. D Joshi, Introduction to General Topology, Wiley Eastern 1983.

3. James. R. Munkres, Topology21. Editich, Pearson International, 2000.
4. J Dugundji, Topology, Prentice-Hail of India,1966.
5. George F. Simmons. Introduction to Topology and Modem Analysis McGraw-Hill, 1963.
6. S. Willard, General Topology, Mdison-wesley, 1970.

Course. prerequisite: To study this course, the students must have had subject Mathematics in class 12th

Suggested continuous Evaluation methods-

Continuous internal Evaluation shall be based on allotted assignments and class text.
The marks shall be as follows:
Internal examination :10
Assignment/Practical/Project : 5
Attendance/Behaviour : 5

Programme: B..Sc. (Honours/Honours with Research) in Mathematics	**Year: B.Sc. IVth Year**	**Semester: VII**

Pedagogy:

Course Code: MAT-23111A	**Course Title: Research Methodology**

Course Outcome: After completing this course, the students will be able to -

CO.1 Understand and ensure uniformity, consistency, reliability and reproducibility of experience
CO2. To understand experimental data and interpretation.
CO3. To understand the principles and applications of basic laboratory methods and instruments
CO4. To know about imply appropriate tools and techniques to solve the problems
CO5.To know about ethic in research field

Credit: 4+0+0	**Paper: Core Compulsory**
Max. Marks: 20+80	**Min Passing Marks: 7+29**

Total Number of Lectures (Lecture +Tutorials + Practical): 60+0+0

Unit	**Topics**	**No. of Lecture**
Unit I	Foundations of Research: Meaning, Objectives, Motivation: Research Methods vs Methodology, Types of Research: Analytical vs Descriptive, Quantitative vs Qualitative, Basic vs Applied	10
Unit II	Research Design: Need for research design— Features of good design, Important concepts related to good design; Observation and Facts, Prediction and Explanation, Development of Models. Developing a research plan: Problem identification, Experimentation, Determining experimental and sample designs	12
Unit III	Data Collection, Analysis and Report Writing, Observation and Collection of Data-Methods of data collection- Sampling Methods, Data Processing and Analysis Strategies, Technical Reports and Thesis writing, Preparation of Tables and Bibliography. Data Presentation using digital technology	16
Unit IV	Biostatistics: Designing of experiments, Null hypothesis, probability, Correlation, regression, Distribution and measurement of central tendency, Chi Square test, Student t test F- test (one way ANOVA, two way ANOVA)	12
Unit V	Ethical Issues, Intellectual Property Rights, Commercialization, Copy Right, Royalty, Patent law, Plagiarism, Citation, Acknowledgement	10

Suggested Readings:

1. Seiler, J.P. (2005). Good Laboratory Practice: the Why and the How. Springer
2. Webster, J. G. (2004). Bioinstrumentation. John Wiley & Sons Incorporated
3. Reilly, M.J. (2016) Bioinstrumentation. CBS Publishers & Distributor
4. Ross, M.H. and Reith, E.J. (1995). Histology A Text and Atlas. Harper International Edition
5. Kiernan j.A. (2015) Histological and Histochemical Methods: Theory and Practice. Pergamon Press
6. Sundar Rao P.S.S. and Richard J. (2012). Introduction to Biostatistics and Research Methods. PHI Private Ltd
7. Sokal R.R. and Rohlf F.J. (2009). Introduction to Biostatistics. Dover Publications.

Course. prerequisite: To study this course, the students must have had subject Mathematics in class 12th

Suggested continuous Evaluation methods-

Continuous internal Evaluation shall be based on allotted assignments and class text.
The marks shall be as follows:
Internal examination :10
Assignment/Practical/Project : 5

Attendance/Behaviour : 5

Or

Programme/ Class: Degree (Honours)	**Year: B.Sc. Fourth Year**	**Semester: VIII**
Subject: Mathematics		
Course Code: [MAT-23111B]	**Course Title: Advanced Real Analysis**	
Course Outcome: After completing this course, the students will be able to -		
CO.1 Understand the Riemann Integral. **CO.2.**After Successful completion of this course, students should have the knowledge of Power series. **CO.3.** know about the property of Partial derivatives. **CO.4.** know about the Uniformly bounded sequence.		
Credit: 4	**Paper: Core Compulsory**	
Max. Marks: 20+80	**Min Passing Marks: 7+29**	
Total Number of Lectures (Lecture +Tutorials + Practical): 4+0+0		

Unit	**Topics**	**No. of Lecture**
Unit I	**Riemann Integral** **:** Partition, lower and upper Riemann-Stieltjes sums, lower and upper Riemann-Stieltjes integrals, Definition of Riemann-Stieltjes integral, necessary and sufficient condition for Riemann-Stieltjes integrability, algebra of Riemann-Stieltjes integrable functions.	10
Unit II	Function, primitive, fundamental theorem of integral calculus, integration by parts, Integration of vector-valued functions.	7
Unit III	Power series, Cauchy's theorem on limits, Radius of convergence, Abel's and Tauber's theorems, Introduction, simultaneous limit, Limit of a function of two variables, continuity of a function of two variables.	8
Unit IV	Introduction, Partial derivatives, partial derivative of higher order, example based on partial derivatives, Introduction, Homogeneous function, Euler's theorem on Homogeneous function, some deductions from Euler's theorem, Jacobians.	10
Unit V	Uniformly bounded sequence, uniform convergence of sequences, Uniform convergence of a series of function, Cauchy's general principle of uniform convergence, test for uniform convergence, Uniform convergence and integration, Uniform convergence and differentiation.	10

Suggested Reading

1. H. L. Royden and P. M. Fitzpatrick, Real Analysis, (Fourth edition), Prentic Hall of India, 2010.
2. M. P. do Carmo; Riemannian Geometry, Berkhauser, 1992.
3. P. Peterson; Riemannian Geometry, Springer, 2006.
4. J. Jost; Riemannian Geometry and Geometric Analysis, Springer, (6th edition), 2011.
5. J. M. Lee; Riemannian Manifolds: An Introduction to Curvature, Springer, 1997.
6. S. Gallot, D. Hullin. J. Lafontaine; Riemannian Geometry, Springer,3rd edition, 2004
7. K. Yano; The Theory of Lie derivatives and its Applications, North Holland Publishing Company, Amsterdom, 1957.

Course. prerequisite: To study this course, the students must have had subject Mathematics in class 12th

Suggested continuous Evaluation methods-

Continuous internal Evaluation shall be based on allotted assignments and class text.

The marks shall be as follows:

Internal examination :10
Assignment/Practical/Project : 5
Attendance/Behaviour : 5

Major (Elective) : Choose Any Two Course

Programme: B..Sc. (Honours/Honours with Research) in Mathematics	**Year: B.Sc. IVth Year**	**Semester: VII**
Pedagogy:		
Course Code: MAT-23112A	**Course Title:** Calculus of Variation and Integral Equation	

Course Outcome: After completing this course, the students will be able to -

CO.1 They will be aware of Euler's equations, Variational problems with moving boundaries**,** isoperimetric problems, Rayleigh-Ritz method, Galerkin's method.
CO2: Will be aware of Classification of integral equations, Neumann's iterative method for Fredholm's equation of second kind.
CO3: Will be aware of Volterra type integral equation, Hilbert Schmidt theory.

Credit: 3+1+0	**Paper: Core (Elective)**
Max. Marks: 20+80	**Min Passing Marks: 7+29**

Total Number of Lectures (Lecture +Tutorials + Practical): 45+15+0

Unit	**Topics**	**No. of Lecture**
Unit I	Euler's equations, Functional dependence order derivatives, Functional dependence on functions of several independent variables. Variational problems with moving boundaries.	9
Unit II	One sided variation, Variational problems with subsidiary conditions, isoperimetric problems, Rayleigh-Ritz method, Galerkin's method.	9
Unit III	Classification of integral equations, Neumann's iterative method for Fredholm's equation of second kind,	9
Unit IV	Volterra type integral equation, integral. Equation of first kind convolution type integral	9
Unit V	Nonlinear voltera equations. Hilbert Schmidt theory.	9

Suggested Readings:

1. A. S. Gupta, Calculus of variations, Prentice Hall of India Put. Ltd. 2003.
2. I. M. Gelfand and S.V. Francis. Calculus of variations, Prentice Hall.New Jersey, 2000.
3. L. G. Chambers, Intergral equation, International Text book company Ltd. London, 1976.
4. F. G. Tricomi, Integral equation, Inter science New York 1957.
5. R. P. Kanwal, Linear Integral equation: Theory and Technique, Birkhauser 1997.

Course. prerequisite: To study this course, the students must have had subject Mathematics in class 12th

Suggested continuous Evaluation methods-

Continuous internal Evaluation shall be based on allotted assignments and class text. The marks shall be as follows: Internal examination :10 Assignment/Practical/Project : 5 Attendance/Behaviour : 5

Or

Programme: B.Sc. (Honours/Honours with Research) in Mathematics	**Year: B.Sc. IVth Year**	**Semester: VII**
Pedagogy:		
Course Code: MAT-23112B	**Course Title: Function of Complex Variable**	
Course Outcome: After completing this course, the students will be able to -		
CO1: Students will be able to know the basic concepts and developments of complex analysis which will prepare the students to takeupfurther applicationsinthe relevantfields.		
Credit: 3+1+0	**Paper: Core (Elective)**	
Max. Marks: 20+80	**Min Passing Marks: 7+29**	
Total Number of Lectures (Lecture +Tutorials + Practical): 45+15+0		

Unit:	**Topics**	**Practical (Hrs.)**
I	Functions of complex variable, Mappings; Mappings by the exponential function, Limits, Theorems on limits, Limits involving the pointatinfinity,Continuity,Derivatives,Differentiationformulae,Cauchy-Riemannequations,Sufficientconditionsfordifferentiability; Analytic functionsandtheirexamples.	9
II	Exponentialfunction,Logarithmicfunction,Branchesandderivativesoflogarithms,Trigonometric function,Derivativesoffunctions,Definiteintegrals offunctions,Contours,Contourintegrals andits examples,Upperbounds formoduliofcontourintegrals.	9
III	Antiderivatives,Proofofantiderivativetheorem,Cauchy-Goursattheorem,Cauchyintegralformula;AnextensionofCauchyintegralformula,Consequences of Cauchyintegralformula,Liouville'stheoremandthefundamentaltheoremofalgebra.	9
IV	Convergenceofsequencesandseries,Taylorseriesanditsexamples;Laurentseriesandits examples,Absoluteanduniformconvergence of power series, Uniqueness of series representations of power series, Isolated singular points, Residues, Cauchy's residuetheorem,residueatinfinity;Types ofisolated singular points,Residuesat polesand itsexamples.	9
V	Schwarz Lemma, Mobius transformation, fixed points off a Mobious transformation, ccross rattiio aand invvrrinnce under mobius transformation.	9

SuggestedReadings(Complex Analysis):

1. FunctionofComplexVariablebyShantiNarain.
2. ComplexvariableandapplicationsbyBrown&Churchill.
3. Suggesteddigitalplateform:NPTEL/SWAYAM/MOOCS.
4. CourseBookspublishedinHindimaybeprescribedbytheUniversities

Course prerequisite: To study this course, the students must have had subject Mathematics in class 12th

Suggested continuous Evaluation methods-

Continuous internal Evaluation shall be based on allotted assignments and class text. The marks shall be as follows: Internal examination :10 Assignment/Practical/Project : 5 Attendance/Behaviour : 5

Or

Programme: B.Sc. (Honours/Honours with Research) in Mathematics	**Year: B.Sc. IVth Year**	**Semester: VII**
Pedagogy:		

Course Code: MAT-23112C		Course Title: Mechanics
Course Outcome: After completing this course, the students will be able to -		
CO1: The object of the paper is to give students knowledge of basic mechanics such as simple harmonic motion, motion under other laws and forces. **CO2:** The student, after completing the course can go for higher problems in mechanic such as hydrodynamics, this will be helpful in getting employment in industry.		
Credit: 3+1+0		**Paper: Core (Elective)**
Max. Marks: 20+80		**Min Passing Marks: 7+29**
Total Number of Lectures (Lecture +Tutorials + Practical): 45+15+0		
Unit:	**Topics**	**Practical (Hrs.)**
I	System of Particles –Energy and Momentum methods. Use of Centroid, Motion of a Rigid Body- Euler's Theorem, Angular momentum and kinetic energy.	9
II	Euler's equation of motion of rigid body with one point fixed, Eulerian angles, motion of a symmetrical top.	9
III	Generalized coordinates. Velocities and momenta, Holonomic and nonholonomic systems, D' Alembert's Principle, Lagrange's equations of motion, Conservative forces.	9
IV	Lagrange's equations for impulsive forces, Theory of small Oscillations of conservative holonomic dynamical system, Hamilton's equations of motion.	9
V	Variational Principle and Principle of Least Action, Contact transformations, Poisson's Brackets, Hamilton Jacobi equation.	9
SuggestedReadings:(Mechanics): • R.C. Hibbeler, Engineering Mechanics - Statics, Prentics Hall Publishers • R.C. Hibbeler, Engineering Mechanics - Dynamics, Prentics Hall Publishers • A. Nelson, Engineering Mechanics Statics and Dynamics, Tata McGraw Hill • J.L. Synge & B.A. Griffith, Principles of Mechanics, Tata McGraw Hill 5. Suggested digital plate form: NPTEL/SWAYAM/MOOCs		
Course prerequisite: To study this course, the students must have had subject Mathematics in class 12th		
Suggested continuous Evaluation methods-		
Continuous internal Evaluation shall be based on allotted assignments and class text. The marks shall be as follows: Internal examination :10 Assignment/Practical/Project : 5 Attendance/Behaviour : 5		

Or

Programme: B.Sc. (Honours/Honours with Research) in Mathematics	Year: B.Sc. IVth Year	Semester: VII
Pedagogy:		
Course Code: MAT-23112D	**Course Title: Mathematical Statistics**	
Course Outcome: After completing this course, the students will be able to -		
CO1: A student learning this course gets a concept of a statistical population and sample. **CO2:** They will be aware of Analysis of Quantitative Data**.** **CO3:** They can use technique of Presentation of Data. **CO4:** On successful completion of the course students should have knowledge about the Bivariate Data.		
Credit: 3+1+0	**Paper: Core (Elective)**	
Max. Marks: 20+80	**Min Passing Marks: 7+29**	
Total Number of Lectures (Lecture +Tutorials + Practical): 45+15+0		
Unit:	**Topics**	**Practical (Hrs.)**
I	Types of data: Concepts of a statistical population and sample from a population, qualitative and quantitative data; nominal and ordinal data; cross sectional and time series data; discrete and continuous data; frequency and non-frequency data.	9
II	Presentation of Data: Construction of tables with one or more factors of classification. Diagrammatic and graphical representation of grouped data. Frequency distributions, cumulative frequency distributions and their graphical	9

	representation.	
III	Analysis of Quantitative Data: Univariate data-Concepts of central tendency or location, dispersion and relative dispersion, skewness and kurtosis, and their measures including those based on quantiles and moments. Sheppard's correction for grouped data (without derivation).	9
IV	Bivariate Data: Scatter diagram. Product moment correlation coefficient and its properties. Coefficient of determination. Concepts of error in regression, linear Regression and related results, Correlation ratio, Rank correlation-Spearman's and Kendall's measures. Intra class correlation.	9
V	Multivariate Data Multiple regression, multiple correlation and partial correlation in three variables. Their measures and related results.	9

SuggestedReadings

1. V. K. Kapoor and S. C. Gupta, Fundamentals of Mathematical Statistics
2. Goon, Gupta and Das Gupta, Fundamentals of Statistics, Vol-I

Course prerequisite: To study this course, the students must have had subject Mathematics in class 12^{th}

Suggested continuous Evaluation methods-

Continuous internal Evaluation shall be based on allotted assignments and class text.

The marks shall be as follows:

Internal examination :10
Assignment/Practical/Project : 5
Attendance/Behaviour : 5

Other Courses:

Minor : To be Choosed from POOL B

SEMESTER-VIII

Programme: B..Sc. (Honours/Honours with Research) in Mathematics	**Year: B.Sc. IVth Year**	**Semester: VIII**
Pedagogy:		
Course Code: MAT-23113	**Course Title:** Functional Analysis	

Course Outcome: After completing this course, the students will be able to -

CO.1 understand the Normed linear space.
CO.2. understand the application of Hilbert space.
CO.3. know about the property of Banach theorem and Housdorff metric space.
CO.4. They know about the Picard's existence and uniqueness theorem.

Credit: 5+1+0	**Paper: Core Compulsory**
Max. Marks: 20+80	**Min Passing Marks: 7+29**

Total Number of Lectures (Lecture +Tutorials + Practical): 75+15+0

Unit	**Topics**	**No. of Lecture**
Unit I	Normed linear space, sequence of series, l^p space, l^∞ space, unit sphere, closed and open ball, subspace of a Banach space, Introduction, linear operators, null space, linear operator, identity operator, zero operator, inverse of a linear operator, bounded linear operator.	15
Unit II	Continuity and null space, linear functional, bounded linear functional, dot product, algebraic dual, Inner product spaces, Hilbert spaces, some properties of Hilbert spaces, orthonormal sets, conjugate space and adjoint of an operator.	15
Unit III	Introduction, Banach fixed point, contraction, Banach fixed point theorem, Kannon contraction theorem, Reich contraction, Hardy and Rogers's contraction theorem.	15
Unit IV	Applications of Banach theorem to linear equations, differential equations, integral equations, Picard's existence and uniqueness theorem.	15
Unit V	Introduction, best approximation, polynomials, uniqueness, convexity, Introduction, distance, Housdorff metric space, Nadler's contraction theorem.	15

SuggestedReading(Normed Linear Space): **1.** Introductory Functional Analysis with Application, Erwin Kreyszig. **2.** Functional Analysis by B.M. Limye.
Course. prerequisite: To study this course, the students must have had subject Mathematics in class 12th
Suggested continuous Evaluation methods-
Continuous internal Evaluation shall be based on allotted assignments and class text. The marks shall be as follows: Internal examination :10 Assignment/Practical/Project : 5 Attendance/Behaviour : 5

MAJOR (ELECTIVE): CHOOSE ANY TWO COURSE

Programme: B..Sc. (Honours/Honours with Research) in Mathematics	**Year: Fourth Year**	**Semester: VII-VIII**
Pedagogy:		
Course Code: MAT-23114A	**Course Title: Measure Theory**	
Course Outcome: After completing this course, the students will be able to - **CO1:** They can use technique of Venn diagram. **CO2:** They will be aware of Schroder-Bernstein's equivalence theorem**.** **CO3:** They can use technique of Measurable function. **CO4:** They will be aware of Measurable set, Exterior and Interior Measure of a set.		
Credit: 3+1+0	**Paper (Code compulsory/Elective): Core Elective**	
Max. Marks: 20+80	**Min Passing Marks: 7+29**	

Total Number of Lectures (Lecture +Tutorials + Practical): 45+15+0

Unit	Topics	No. of Lecture
Unit I	Introduction, Representation of sets, types of sets, subset, universal set, Venn diagram, operations on sets, and algebra of sets, Introduction, inverse relation, representation of relations, types of relations, equivalence relation, and partial order relation.	9
Unit II	Introduction, inverse function, types of functions, real valued function, identity function, constant function, composition of functions.	9
Unit III	Zorn Lemma, axiom of choice, Schroder-Bernstein's equivalence theorem, Open and closed sets, Bolzano-Weierstrass theorem.	9
Unit IV	Length of an interval, measure of interval, Borel set, Boolean Ring, Boolean algebra, measure, Outer Measure, Carathedory's Postulates for Outer Measure, Measurable set, Exterior and Interior Measure of a set, Measurable space, First Fundamental Theorem, Cantor's Ternary set.	9
Unit V	Measurable function, Borel Measurability, pointwise convergence, convergence in measure, uniform convergence, F. Riesz theorem, Egoroff's theorem and Lusin's theorem.	9

SuggestedReading

1.H. L. Royden and P. M. Fitzpatrick, Real Analysis, (Fourth edition), Prentic Hall of India, 2010.
2. Inder K. Rana, An introduction Measure and integration,(Second edittion) Narosa, Publishing House, New Delhi, 2005.
3. G. de Barra, Measure Theory and integration, John Wiley & Sons, 1981.
4. J.L. Kelly. T.P. Srinivasan, Measure and Integration Springer, 1988.
5. K. R. Parthasarathy, Introduction to Probability and Measure TRIM 33 Hindustan Book Agency, New Delhi , 2005

Course. prerequisite: To study this course, the students must have had subject Mathematics in class 12th
Suggested continuous Evaluation methods-
Continuous internal Evaluation shall be based on allotted assignments and class text. The marks shall be as follows: Internal examination :10 Assignment/Practical/Project : 5 Attendance/Behaviour : 5

Or

Programme: B..Sc. (Honours/Honours with Research) in Mathematics	Year: Fourth Year	Semester: VIII

Pedagogy:

Course Code: MAT-23114B	Course Title: Probability Theory

Course Outcome: After completing this course, the students will be able to -

CO1: They can use technique of Probability.
CO2: They will be aware of Random Variable and Random
CO3: They can use technique of Statistical Distributions.
CO4: They will be aware of Normal distribution.

Credit: 3+1+0	Paper (Code compulsory/Elective): Core Elective
Max. Marks: 20+80	Min Passing Marks: 7+29

Total Number of Lectures (Lecture +Tutorials + Practical): 45+15+0

Unit	Topics	No. of Lecture
Unit I	Random Experiment and Probability Measure Random experiments, sample space, events, algebra of events, axiomatic definition of probability, probability spaces, relationship of axiomatic and classical probability, role of frequency ratios, properties of probability measure, subadditivity, Boole's inequality, probability of union of events, conditional probability and associated probability space, Bayes theorem, independence of events.	9
Unit II	Random Variable and Random Vector Random variables as functions, induced probability measure via inverse mapping, induced probability distribution, distribution functions, distribution functions and their properties, probability mass function (pmf) of discrete random variables, probability density function (pdf) of continuous random variables, Random vector.	9
Unit III	Mathematical Expectation and Functions of Random Variables, moments, factorial moments, moment generating function, probability generating function, Expectation of jointly distributed random variables.	9
Unit IV	Statistical Distributions: Bernoulli distribution: binomial distribution: Poisson distribution, derivation of Poisson distribution as a limiting case of binomial distribution, geometric distribution, negative binomial distribution.	9
Unit V	Normal distribution and its relationship with the binomial and Poisson distribution, Cauchy distribution, bivariate normal distribution and its marginal and conditional distributions.	9

SuggestedReading

1. Beumont, G.P.: Probability and random variables.
2. Meyer, Paul L. (1970): Introductory probability and statistical applications, Addision Wesley.
3. Mukhopadhyay, P. (1996): Theory of Probability, New Central Book Agency, Calcutta.
4. Parzen, E. (1960): Probability theory and its applications, Wiley Eastern.

Course. prerequisite: To study this course, the students must have had subject Mathematics in class 12^{th}

Suggested continuous Evaluation methods-

Continuous internal Evaluation shall be based on allotted assignments and class text.
The marks shall be as follows:
Internal examination :10
Assignment/Practical/Project : 5
Attendance/Behaviour : 5

Or

Programme: B..Sc. (Honours/Honours with Research)	Year: Fourth Year	Semester: VIII

in Mathematics		
Pedagogy:		
Course Code: MAT-23114C	**Course Title: Advanced Algebra**	
Course Outcome: After completing this course, the students will be able to -		
CO1: They can use technique of Probability. **CO2:** They will be aware of Random Variable and Random **CO3:** They can use technique of Statistical Distributions. **CO4:** They will be aware of Normal distribution.		
Credit: 3+1+0	**Paper (Code compulsory/Elective): Core Elective**	
Max. Marks: 20+80	**Min Passing Marks: 7+29**	
Total Number of Lectures (Lecture +Tutorials + Practical): 45+15+0		

Unit	Topics	No. of Lecture
Unit I	**Introduction to rings, fields, and integral domains**. • Ring properties: commutativity, associativity, and distributivity. • Ideals, subrings, and quotient rings. • Introduction to modules over a ring.	9
Unit II	**Polynomial Rings and Factorization** • Polynomial rings and their properties. • Division algorithm and polynomial factorization. • Irreducibility criteria for polynomials. • Unique factorization domains (UFDs) and principal ideal domains (PIDs).	9
Unit III	**Field Extensions and Galois Theory** • Field extensions and algebraic extensions. • Minimal polynomials and algebraic elements. • Introduction to Galois theory and automorphisms. • Fundamental theorem of Galois theory.	9
Unit IV	**Group Theory and Representation Theory** • Group actions, orbits, and stabilizers. • Sylow theorems and applications. • Introduction to representation theory of groups. • Maschke's theorem and irreducible representations.	9
Unit V	**Homological Algebra and Advanced Topics** • Introduction to homological algebra and chain complexes. • Exact sequences and homology groups. • Introduction to advanced topics, such as commutative algebra or algebraic geometry. • Discussion of open problems and modern research in advanced algebra.	9

SuggestedReading

1. "Abstract Algebra" by David S. Dummit and Richard M. Foote
   This comprehensive textbook provides an in-depth introduction to abstract algebra, covering groups, rings, fields, modules, and other advanced algebraic structures. It includes numerous examples, exercises, and applications.

2. "A First Course in Abstract Algebra" by John B. Fraleigh
   This classic textbook offers a clear and accessible introduction to abstract algebra. It covers group theory, ring theory, and field theory, with emphasis on foundational concepts and problem-solving techniques.

3. "Algebra" by Michael Artin
   Artin's book presents abstract algebra from a geometric perspective, connecting algebraic concepts to real-world visualizations. It covers topics such as groups, rings, fields, and Galois theory.

4. "Algebra: Chapter 0" by Paolo Aluffi
   This unique textbook provides a modern and rigorous approach to algebra, starting from basic set theory and progressing to advanced topics like category theory and homological algebra. It's suitable for students seeking a deeper understanding.

5. "Topics in Algebra" by I.N. Herstein
   Herstein's book is known for its clear exposition and comprehensive coverage of topics in algebra. It covers group theory, ring theory, and field theory, providing a solid foundation for advanced study.

6. "Algebra" by Serge Lang
   Serge Lang's algebra series is renowned for its clarity and depth. It covers a wide range of algebraic concepts,

including groups, rings, fields, and Galois theory, with a focus on both theoretical understanding and practical applications.

7. "Introduction to the Theory of Algebraic Structures" by Joseph Rotman
   Rotman's book introduces various algebraic structures, including groups, rings, and fields. It also covers topics like homomorphisms, factor groups, and ideals, providing a solid foundation for advanced algebra.

8. "Basic Algebra I" by Nathan Jacobson
   Jacobson's book is a rigorous introduction to algebraic structures, covering groups, rings, modules, and fields. It's known for its clear exposition and thorough treatment of the subject.

9. "Algebraic Structures and Applications: A First Course" by Philippe Gille and Tamas Szamuely
   This book offers a modern treatment of algebraic structures with a focus on applications in geometry, number theory, and other areas. It covers topics such as group theory, field extensions, and Galois theory.

Course. prerequisite: To study this course, the students must have had subject Mathematics in class 12th

Suggested continuous Evaluation methods-

Continuous internal Evaluation shall be based on allotted assignments and class text.
The marks shall be as follows:
Internal examination :10
Assignment/Practical/Project : 5
Attendance/Behaviour : 5

Or

Programme: B..Sc. (Honours/Honours with Research) in Mathematics	**Year: Fourth Year**	**Semester: VIII**
Pedagogy:		
Course Code: MAT-23114D	**Course Title: Optimization Techniques**	

Course Outcome: After completing this course, the students will be able to -

CO1: They can use technique of optimization.
CO2: They will be aware of Fibonacci method
CO3: They can use technique of linear programming problem
CO4: They will be aware of saddle point.

Credit: 3+1+0	**Paper (Code compulsory/Elective): Core Elective**
Max. Marks: 20+80	**Min Passing Marks: 7+29**

Total Number of Lectures (Lecture +Tutorials + Practical): 45+15+0

Unit	**Topics**	**No. of Lecture**
Unit I	Introduction, Optimization techniques, applications of optimization techniques, optimization problems, classification of optimization problems, Introduction, unconstrained optimization problem, single and multi-variable optimization problems.	9
Unit II	Introduction, constrained optimization problem, constrained multi-variable optimization problem with equality and inequality constraints.	9
Unit III	Introduction, unconstrained non-linear optimization problems, direct search method: Fibonacci method of search, Golden section method, univariate method and pattern search method, indirect search method: steepest descent method.	9
Unit IV	Introduction, solution of linear programming problem using dynamic programming and applications of dynamic programming problem.	9
Unit V	Introduction, shortest route problem, minimum spanning tree problem and maximum flow problem, Introduction, Game theory, lower and upper value of game, procedure to find saddle point, games without saddle point.	9

SuggestedReading:
1. H. A. Taha, Operations Research: An Introduction.
2. P. K. Gupta and D. S. Hira, Operations Research.
3. G. Srinivasan, Operations Research Principle & Applications.

Course. prerequisite: To study this course, the students must have had subject Mathematics in class 12th

Suggested continuous Evaluation methods-

Continuous internal Evaluation shall be based on allotted assignments and class text.
The marks shall be as follows:
Internal examination :10
Assignment/Practical/Project : 5
Attendance/Behaviour : 5

Programme: B.Sc. (Honours/Honours with Research) in Mathematics	**Year: B.Sc. 4th Year**	**Semester: VIIIth**
Pedagogy:		
Course Code: MAT-23115A	Course/Paper Title:	Disseration/Research Project & Viva voce [For Hons. with Research Students]
Course Outcomes: After completing this course, the students will be able to -		
CO 1: acquire Research Skills and awareness about Methodology		
CO 2: develop critical thinking skills for evaluating existing literature and research gaps.		
CO 3: develop Communication Skills, Analytical and Problem-Solving abilities.		
CO 4: develop Project Management and will be able to contribute to existing knowledge		
CO 5: Collaborate in Interdisciplinary Skills.		
Credit: 08		Paper (Core Compulsory / Elective): Compulsory
Max. Marks : 20 + 80		
Total Number of Lectures (Lecture – Tutorials – Practical): 0+0+8		

Units:	Topics:	No. of Lectures
I	Dissertation/ Research Project & Viva Voce	240

Suggested Readings:

1. "Research Design: Qualitative, Quantitative, and Mixed Methods Approaches" by John W. Creswell and J. David Creswell
   This book covers various research designs and approaches, helping you select the most appropriate one for your dissertation. It's suitable for both qualitative and quantitative research.
2. "The Craft of Research" by Wayne C. Booth, Gregory G. Colomb, and Joseph M. Williams
   This book is a comprehensive guide to the research process, from formulating research questions to presenting findings. It offers practical advice and strategies for effective research.
3. "How to Write a Better Thesis" by David Evans, Paul Gruba, and Justin Zobel
   Geared towards graduate students, this book provides practical guidance on planning, writing, and revising a thesis or research project. It covers a range of disciplines and research methods.
4. "Completing Your Qualitative Dissertation: A Roadmap from Beginning to End" by Linda Dale Bloomberg and Marie F. Volpe
   Focused on qualitative research, this book offers step-by-step guidance on the entire dissertation process, including choosing a topic, data collection, analysis, and writing.
5. "Writing Your Dissertation in Fifteen Minutes a Day" by Joan Bolker
   This book offers practical strategies to help you overcome writer's block and procrastination while writing your dissertation. It emphasizes consistent writing habits.
6. "The Dissertation Journey: A Practical and Comprehensive Guide to Planning, Writing, and Defending Your Dissertation" by Carol M. Roberts
   This book provides a holistic approach to the dissertation process, covering topics such as time management, literature review, research design, and defense preparation.
7. "How to Design, Write, and Present a Successful Dissertation Proposal" by Elizabeth A. Wentz
   Focusing on the proposal stage, this book offers guidance on crafting a clear and effective dissertation proposal, including outlining research questions and methodologies.
8. "Writing the Successful Thesis and Dissertation: Entering the Conversation" by Irene L. Clark
   This book emphasizes the importance of contributing to the scholarly conversation in your field and provides practical advice on how to structure and present your research.
9. "The Literature Review: Six Steps to Success" by Lawrence A. Machi and Brenda T. McEvoy
   A comprehensive guide to conducting a literature review, a crucial component of any research project or dissertation.

10. "Demystifying Dissertation Writing: A Streamlined Process from Choice of Topic to Final Text" by Peg Boyle Single

This book offers a straightforward and organized approach to the dissertation process, helping you break down the tasks and stay on track.

Suggested continuous E-Valuation Methods –

Continuous Internal Evaluation (CIL)

Totalmarksforeachcourseshallbebasedoninternalassessment(20%)andsemester end examination (80%).The internal assessment of 20% shall be distributedasunder:

(iv) Internal Class Test – 10%.

(v) Assignment/Project/Practical – 5%

(vi) Attendance/Behavior – 5%.

Or

Field Visit/ Educational Tour Visit based Viva Voce [Course Code : MAT-23115B] for (Hons. Students)

Completion of the Programme:Bachelor Degree with Honours/Honours with Research in Major Discipline at the Successful Completion of the Fourth Year (Eight Semesters) of the multidisciplinary Four-year Undergraduate Programme.

POOL-B

Minor Discipline Courses (For I & IInd Semester) : Can be Choosed by All Discipline Students

Year	Semester	Nomenclature/Title of the Course	VAC Code	Credit
1st Year	I	Modern Indian language – Hindi P-I	MIN-001	2
		Modern Indian language – Sanskrit P-I	MIN-002	2
		Modern Indian language – English language P-I	MIN-003	2
1st Year	II	Modern Indian language – Hindi P-II	MIN-004	2
		Modern Indian language – Sanskrit P-II	MIN-005	2
		Modern Indian language – English language P-II	MIN-006	2

POOL-C

Skill Enhancement Courses

S.N.	SEC Code	Title of SEC / Vocational Courses	Level	COM./ELE	Credits (L/T+P)
1	SEC-001	Digital Marketing	NSQF 5	ELE.	1+2
2	SEC-002	Culinary Arts	NSQF 5	ELE.	1+2
3	SEC-003	Tourism & Travel Management	NSQF 5	ELE.	1+2
4	SEC-004	Early Childhood Education	NSQF 5	ELE.	1+2
5	SEC-005	Sports Coaching	NSQF 5	ELE.	1+2
6	SEC-006	Financial accounting & Taxation	NSQF 5	ELE.	1+2
7	SEC-007	Retail Management	NSQF 5	ELE.	1+2
8	SEC-008	Supply Chain Management	NSQF 5	ELE.	1+2
9	SEC-009	Digital Photography & Videography	NSQF 5	ELE.	1+2
10	SEC-010	Yoga and Nutrition Expert	NSQF 5	ELE.	1+2
11	SEC-011	Disaster Management	NSQF 5	ELE.	1+2
12	SEC-012	Digital Library Establishment	NSQF 5	ELE.	1+2
13	SEC-013	Computerized Accounting (Tally)ERP-9/Prime)	NSQF 5	ELE.	1+2
14	SEC-014	Apiculture	NSQF 5	ELE.	1+2
15	SEC-015	Aquaculture	NSQF 5	ELE.	1+2
16	SEC-016	Vermiculture	NSQF 5	ELE.	1+2
17	SEC-017	Sericulture	NSQF 5	ELE.	1+2
18	SEC-018	Horticulture	NSQF 5	ELE.	1+2
19	SEC-019	Mushroom Cultivation	NSQF 5	ELE.	1+2
20	SEC-020	Herbal Technology	NSQF 5	ELE.	1+2
21	SEC-021	Basic Instrumentation Skills	NSQF 5	ELE.	1+2
22	SEC-022	Digital Electronics	NSQF 5	ELE.	1+2
23	SEC-023	Organic Farming	NSQF 5	ELE.	1+2
24	SEC-024	Water Management (Ganges)	NSQF 5	ELE.	1+2
25	SEC-025	Computational Chemistry	NSQF 5	ELE.	1+2
26	SEC-026	Industrial Chemistry	NSQF 5	ELE.	1+2
27	SEC-027	Jyotish Shashtra and Karmakand	NSQF 5	ELE.	1+2
28	SEC-028	Vastushastra	NSQF 5	ELE.	1+2
29	SEC-029	Radio Jockey CCRJ	NSQF 5	ELE.	1+2

POOL-D

Value Added Courses

Year	Semester	Nomenclature/Title of the Course	VAC Code	Credit
1st Year	I	Understanding India	VAC-001	2
1st Year	II	Communication Skills and Personality development	VAC-002	2
2nd Year	III	Indian Heritage and Culture	VAC-003	2
2nd Year	IV	Food, Nutrition and Hygiene	VAC-004	2
3rd Year	V	GramPravas and Talking Hands	VAC-005	2
3rd Year	VI	Physical Education and Yoga	VAC-006	2