Head of the Department Mathematics Institute of Applied Sciences & Humanities GLA University, Mathura

GLA University, Mathura

(NAAC Accredited 'A+' Grade)



Curriculum and Syllabi of M.Sc. Mathematics

(w. e. f. Session 2024-2025)

With Choice Based Credit System (CBCS)

DEPARTMENT OF MATHEMATICS

Institute of Applied Sciences and Humanities

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VISION AND MISSION

Vision and Mission of the University

Vision

We envision ourselves as a pace-setting university of Academic Excellence focused on education, research and development in established and emerging professions.

Mission

- M1: To impart quality professional education, to conduct commendable research and to provide credible consultancy and extension services as per current and emerging socio-economic needs.
- M2: To continuously enhance and enrich the teaching/learning process and set such standards, education and otherwise, that other institutes would want to emulate.
- M3: To be totally student-centric, thus promoting the overall growth and development of intellect and personality of our prime stakeholders, namely students, so that our alumni are worthy citizens and highly sought-after professionals worldwide.
- M4: To empower the members of faculty and staff so that the university's ambience is one of harmony, mutual respect, cooperative endeavour and receptivity towards positive ideas.
- **M5:** To proactively seek regular feedback from all the stakeholders and take appropriate measures based on them thus leading to excellent learning process. Be totally student-centric, thus promoting the overall growth and development of intellect and personality of our prime stakeholders, namely students, so that our alumni are worthy citizens and highly sought-after professionals worldwide.

Vision and Mission of the Department

Vision

The department aims to be a center of excellence in Mathematics, computing and is vigorously engaged in both research and teaching.

Mission

- **M-1:** To perform widely recognized research in focused areas of mathematical and statistical theory, methodology, and education.
- **M-2:** To explore applications of Mathematics and Statistics and engage in collaborative research in an interdisciplinary environment.
- **M-3:** To discover, mentor, and nurture mathematically inclined students, and provide them a supportive environment that fosters intellectual growth.
- **M-4:** To prepare our postgraduate students to develop the attitude and ability to apply mathematical methods and ideas in a wide variety of careers.
- **M-5:** To provide professional services based on our diverse mathematical and statistical expertise to the scientific, technical, and educational community.

1. BACKGROUND

i) National Educational Policy (NEP) - 2020

The curricular reforms are instrumental for the desired learning outcomes. In view of this, the Department of Mathematics of Institute of Applied Sciences and Humanities of GLA University, Mathura, U.P. took initiative to revise the curriculum of its postgraduate program in alignment with National Education Policy-2020. The key features of the policy were discussed in the meeting of heads of various departments with the hon'ble Vice Chancellor and the action plan was made with well-defined responsibilities and timeline for academic reforms.

The process of modifying the curriculum started with the series of webinars and discussions conducted by the University to orient the teachers about the key features of the policy, enabling them to revise the curriculum in sync with the policy. Proper orientation of the faculty about the vision and provisions of NEP-2020 made it easier for them to incorporate the vital aspects of the policy in the revised curriculum focused on creating holistic and innovative individuals equipped with the key skills for the development of an enlightened, socially conscious, skilled and self-sustained nation.

The revised curricula articulate the spirit of the policy by emphasizing upon—integrated approach to learning; innovative pedagogy and assessment strategies; multidisciplinary education; critical thinking; ethical values; entrepreneurial and professional skills; social, moral and environmental awareness; holistic, discussion-based, and analytical learning; flexibility in choice of courses; student-centric participatory learning; offering multiple entry and exit points; integration of extra-curricular and curricular aspects; closer collaborations between industry and higher education institutions for science programs; and formative assessment tools to be aligned with the learning outcomes, capabilities, and dispositions as specified for each course. The University has also developed consensus on adoption of Blended Learning with 40% component of online teaching and 60% face to face classes for each program.

The revised curricula of PG program could be devised with efforts of the faculty and head of the department. The draft prepared by the department was discussed in a series of discussion sessions conducted at department and the University level. The Dean, Academic affairs of the University conducted a series of meetings with Heads and Deans to deliberate upon the parameters of the revised curriculum to formulate a uniform template featuring background, Programme Outcomes (POs), Structure of Master's Course, Semester-wise Courses and Credit Distribution, Course-level Learning Outcomes, Teaching-Learning Process. The experts of the Board of Studies contributed to a large extent in giving the final shape to the revised curriculum.

ii) About Mathematics

"Mathematics is the most beautiful and the most powerful creation of the human spirit."

- Stefan Banach

Mathematics is a vital tool for global knowledge and communication that organizes and prevents chaos in our life. Mathematics aids in our understanding of the world and is a good tool for developing mental discipline. Logical reasoning, critical thinking, creative thinking, abstract or spatial thinking, problem-solving abilities, and even effective communication skills are all fostered by mathematics. Mathematics is required to know all other fields of sciences. In one way or another, they all rely on mathematics. The scale of mathematics influences the discipline and mastery of any other science or art.

iii) About the programme

(a) **Objectives:** M.Sc. programme in Mathematics at GLA University, Mathura, aims to help in building foundation in Statistics, Data Analysis, Data Mining, Geometry, Topology, Algebra, Economics and Applied Mathematics. M.Sc. in Mathematics involves advanced studies of Mathematics and Statistics laying a strong foundation which would support employability in industry as well as background for research. While pursuing M.Sc. (Mathematics) degree from GLA University, the students will develop practical knowledge, critical thinking, data handling, quantitative aptitude and conceptual skills. With an objective to foster the analytical skills among the students, M.Sc. (Mathematics) course is the best for those who want to formulate the calculative and mathematical approach.

(b) **Duration:** M.Sc. Mathematics is a full time post graduate level program offered by the Department of Mathematics, IAH, GLA University. This is a two year program, consisting of four semesters with two semesters per year.

- (c) Eligibility: The admission aspirant to the program must have studied Mathematics in Graduation and have scored at least 50% marks in aggregate, OR,
 - He / She must have studied Mathematics at 10+2 level.
 - He / She must have a valid GLAET score

Qualification Descriptors (Possible Career Pathways)

Scope of Employability

After successfully completing this postgraduate program, the students receive a master degree "**Master of Science in Mathematics**". Upon completion of this program, the students will be able to further extend their research in Mathematics. They will also be expected to develop life skills in addition to mathematical ability, as are required to have a wealthy life.

The following career paths possibly open up as a result of pursuing a master degree in Mathematics:

- 1. Teaching
- 2. Research
- 3. Banking
- 4. Actuarial Sciences
- 5. Data Scientist
- 6. Military Operations
- 7. Market Researcher
- 8. Numerical Analyst
- 9. Research Analyst
- 10. Foreign Exchange Traders
- 11. Production Manager
- 12. Investment Researcher
- 13. Information Scientist
- 14. System Analyst
- 15. Market Research Analyst



2. PROGRAMME OUTCOMES (POs)

The students enrolled in the Master's Program offered by the Department of Mathematics under Institute of Applied Sciences and Humanities will have the opportunity to learn and master the following components in addition to attain important essential skills and abilities:

PO No.	PROGRAM OUTCOMES (POs)
PO- 1	Independently carry out research /investigation and development work to solve practical problems.
PO- 2	Write and present a substantial research report/document.
PO- 3	Demonstrate a degree of mastery, at a level higher than the requirements in the appropriate bachelor program, over the area as per the program's specialization.

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3. STRUCTURE OF MASTER'S COURSE

Types of Courses	Nature	Total Credits	%
Program Core Courses (C)	Compulsory	44	39%
Elective Courses (DSE)	Discipline Specific Elective Courses	36	32%
Skilled-based Courses (SEC)	Skill Enhancement Elective Course	3	3%
Ability Enhancement Courses (AECC)	Compulsory	4	3%
Humanities and Social Sciences Courses (HSSC)	Compulsory	10	9%
Projects (J)	Compulsory	16	14%
]	113	100%	

Note: The Scheme and Syllabus of the programme are subject to change as per the UGC guidelines, CBCS Scheme and University ordinance.

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Course Type Program Core Courses (C) Discipline Specific Elective Courses (DSE) Skill Enhancement Elective Courses (SEC) Ability Enhancement Compulsory Courses (AECC) Humanities and Social Sciences Courses (HSSC) Projects (J)

Total Credits: 113, Semester-wise distribution of credits: 27+ 31 + 29 + 26

S. No.	Course Code	Course Title		Т	Р	J	Credit
1	MMAC 1001	Real Analysis		1	0	0	4
2	MMAC 1002	Abstract Algebra	3	1	0	0	4
3	MMAC 0003	Ordinary Differential Equations	3	1	0	0	4
4	MMAC 1004	Linear Algebra	3	1	0	0	4
5	MMAC 1005	Statistical Analysis	3	1	0	0	4
6	MMAC 1006	Operational Research - I	3	1	0	0	4
7	MMAC 0007	Topology	3	1	0	0	4
8	MMAC 0009	Functional Analysis	3	1	0	0	4
9	MMAC 1010	Partial Differential Equations-I	3	1	0	0	4
10	MMAC 1013	Numerical Analysis	3	1	0	0	4
11	MMAC 0014	Complex Analysis	3	1	0	0	4

PROGRAM CORE COURSES(C)

Discipline Specific Elective Courses (DSE) Bouquet 1

(Offered to the students of M.Sc. Mathematics by the Department)

S. No.	Course Code	CourseTitle	L	Т	Р	J	Credit
1	MMAE 0001	Differential Geometry	4	0	0	0	4
2	MMAE 0002	Special Relativity	4	0	0	0	4
3	MMAE 0003	General Relativity and Cosmology	4	0	0	0	4
4	MMAE 0004	Special Functions	4	0	0	0	4
5	MMAE 0006	Partial Differential Equations-II	4	0	0	0	4
6	MMAE 0007	Fluid Dynamics-I	4	0	0	0	4
7	MMAE 0008	Fluid Dynamics-II	4	0	0	0	4
8	MMAE 1009	Discrete Mathematics	4	0	0	0	4
9	MMAE 0010	Integral Equation	4	0	0	0	4
10	MMAE 0011	Optimization Techniques	4	0	0	0	4
11	MMAE 0012	Non-Linear Programming	4	0	0	0	4
12	MMAE 0013	Operator Theory	4	0	0	0	4
13	MMAE 0014	Measure Theory and Integration	4	0	0	0	4
14	MMAE 0015	Fixed Point Theory	4	0	0	0	4
15	MMAE 0016	Finite Element Method	4	0	0	0	4
16	MMAE 0017	Operational Research-II	4	0	0	0	4
17	MMAE 0018	Fractional Calculus	4	0	0	0	4
18	MMAE 0019	Mathematical Modeling	4	0	0	0	4
19	MMAE 0020	Fuzzy Set Theory	4	0	0	0	4
20	MMAE 0021	Numerics of Ordinary Differential Equations	4	0	0	0	4
21	MMAE 0022	Numerics of Partial Differential Equations	4	0	0	0	4
22	MMAE 0023	Mathematics for Finance	4	0	0	0	4
23	MMAE 0024	Coding Theory	4	0	0	0	4
24	MMAE 0025	Cryptography	4	0	0	0	4
25	MMAE 0026	Wavelet Analysis	4	0	0	0	4
26	MMAE 0027	Information Theory	4	0	0	0	4

Bouquet 2

S.No.	Coursecode	Coursetitle	L	Τ	P	J	Credit
1.	MMAE 0101	Probability Theory and Distributions	4	0	0	0	4
2	MMAE 0102	Regression Analysis and Predictive Modelling	4	0	0	0	4
3	MMAE 0103	Time Series Analysis and Forecasting	3	0	2	0	4
4	MCAC 0009	Database Management System	3	0	0	0	3
5	MCAC 0807	Database Management System Lab	0	0	2	0	1
6	MMAE 0104	Machine Learning for Data Science	3	0	2	0	4
7	MMAE 0105	Deep Learning	3	0	2	0	4
8	MMAE 0106	Multivariate Analysis and Stochastic Processes	3	0	2	0	4
9	MMAE 0107	Big Data Analytics	3	0	2	0	4
10	MCAE 0306	Cloud Computing	3	0	0	0	3
11	MCAE 0372	Cloud Computing Lab	0	0	2	0	1
12	MMAE 0108	Statistical Inference	3	0	2	0	4
13	MMAE 0109	Actuarial Statistics	3	0	2	0	4
14	MMAE 0111	Statistical Computing	3	0	2	0	4
15	MMAE 0112	Artificial Intelligence for Data Science	3	0	2	0	4
16	MMAE 0113	Pattern Recognition	3	0	2	0	4
17	MMAE 0114	Design of Experiments and Analysis of Variance	3	0	2	0	4
18	MMAE 0115	Statistical Quality Control	3	0	2	0	4
19	MMAE 0116	Bio-Statistics	3	0	2	0	4
20	BCSE 0152	Data Mining and Warehousing	3	0	0	0	3
21	BCSE 0181	Data Mining and Warehousing Lab	0	0	2	0	1
22	MMAE 0117	Econometrics	3	0	2	0	4
23	MMAE 0118	Survival Analysis	3	0	2	0	4
24	MMAE 1009	Discrete Mathematics	4	0	0	0	4
25	MMAE 0011	Optimization Techniques	4	0	0	0	4

(Offered to the Students of Specialization Data Science)

Skill Enhancement Elective Courses (SEC)

This may include a course based on Theoretical/ Experimental/ Computational Techniques/ Methods.

S.No.	Course Code	ode Course Title		Т	Р	J	Credits
1.	MCAC 0016	Programming in Python (offered by CEA)	3	0	0	0	3
2.	MCAC 0810	Python Programming Lab(offered by CEA)	0	0	2	0	1
3.	BBAK 2804	Applications of MS Excel (offered by IBM)	2	0	2	0	3

Ability Enhancement Compulsory Courses (AECC)

S.No.	Course Code	Course Title	L	Т	Р	J	Credits
1.	MELH 0006	Technical Writing (offered by English Dept.)	4	0	0	0	4

Humanities and Social Sciences Courses (HSSC)

S. No.	Course Code	Course Title	L	Т	Р	J	Credits
1.	BSDH 0301	ft Skills-I (offered by T&D Dept.)		0	0	0	3
2.	BSDH 0302Soft Skills-II (offered by T&D Dept.)30		0	0	3		
3.	ONLH 0002	Ethics in Engineering Practice (Through NPTEL/SWAYAM Platform)	Onsight Mode (Min. 8 Weeks)			2	
4.	BCHS 0201	Environmental Studies (offered by Chem. Dept.)	2	0	0	0	2

Projects (J)

S. No.	Course Code	Course Title	L	Т	Р	J	Credits
1.	MMAJ 0962	Project-I	0	0	0	4	4
2.	MMAJ 0963	Project-II	0	0	0	4	4
3.	MMAJ 0964	Project-III	0	0	0	4	4
4.	MMAJ 0965	Project-IV	0	0	0	4	4

4. SEMESTER-WISE COURSES AND CREDIT DISTRIBUTION

SEMESTER-I

Total Credits: 27 (C: 20, J: 4, HSSC: 3)

Sr.	Course	Course Code	Course Title	L	Т	P	J	Hrs/Week	Total
No.	No.								Credits
Prog	gram Core	e Courses (C)							
1	1	MMAC 1001	Real Analysis	3	1	0	0	4	4
2	2	MMAC 1002	Abstract Algebra	3	1	0	0	4	4
3	3	MMAC 0003	Ordinary Differential Equation	3	1	0	0	4	4
4	4	MMAC 1004	Linear Algebra	3	1	0	0	4	4
5	5	MMAC 1005	Statistical Analysis	3	1	0	0	4	4
Proj	ects (J)								
6	6	MMAJ 0962	Project-I	0	0	0	4	4	4
Hun	nanities ar	nd Social Scienc	es Course (HSSC)						
7	7	BSDH 0301	Soft Skills-I	3	0	0	0	3	3

SEMESTER-II

Total Credits: 31 (C: 12, DSE: 8, AECC: 4, J:4, HSSC: 3)

Sr. No.	Course No.	Course Code	Course Title	L	Т	Р	J	Hrs/ Week	Total Credits
Pro	gram Co	ore Courses (C)							
1	8	MMAC 1006	Operational Research - I	3	1	0	0	4	4
2	9	MMAC 0007	Topology	3	1	0	0	4	4
3	10	MMAC 0009	Functional Analysis	3	1	0	0	4	4
Disc	cipline S	pecific Elective Courses (DSE)							
4	11	MMAE 0001-0004, 0006-0008,	DSE-I	4/3	0	0/2	0	4	4
5	12	MMAE 0101-0108, 0110-0118, MCAC 0009, 0807; MCAE 0306, 0372; BCSE 0152, 0181	DSE-II	4/3	0	0/2	0	4	4
Abi	lity Enha	ancement Compulsory Course	e (AECC)						
6	13	MELH 0006	Technical Writing	4	0	0	0	4	4
Proj	jects (J)								
7	14	MMAJ 0963	Project-II	0	0	0	4	4	4
Hur	nanities	and Social Sciences Course (H	ISSC)						
8	15	BSDH 0302	Soft Skills-II	3	0	0	0	3	3

SEMESTER-III

Total Credits: 29 (C: 12, DSE: 8, SEC: 3, J:4, AECC: 2)

Sr. No.	Course	Course Code	Course Title		Т	Р	J	Hrs/Week	Total Credits
Prog	ram Col	re Courses (C)							cicuits
1	16	MMAC 1010	Partial Differential Equation-I	3	1	0	0	4	4
2	17	MMAC 1013	Numerical Analysis	3	1	0	0	4	4
3	18	MMAC 0014	Complex Analysis	3	1	0	0	4	4
Disci	pline Sp	ecific Elective Courses (DSE)							
4	19	MMAE 0001-0004, 0006-0008,	DSE-III	4/3	0	0/2	0	4	4
5	20	MMAE 0101-0108, 0110-0118, MCAC 0009, 0807; MCAE 0306, 0372; BCSE 0152, 0181	DSE-IV	4/3	0	0/2	0	4	4
Skill	Enhanc	ement Elective Courses (SEC)							
6	21	BBAK 2804	Applications of MS Excel	2	0	2	0	3	3
Proje	ects (J)		·	•		•			
7	22	MMAJ 0964	Project-III	0	0	0	4	4	4
Hum	anities a	nd Social Sciences Course (H	SSC)						
8	23	ONLH 0002	Ethics in Engineering Practice (NPTEL/SWAYAM)	Ons	ight N	/lode ((Min	. 8 Weeks)	2

SEMESTER-IV

Total Credits: 26 (DSE: 20, SEC: 2, AECC: 4)

Sr.	Course	Course Code	Course Title	L	Т	P	J	Hrs/	Total
No.	No.							Week	Credits
Disci	pline Sp	ecific Elective Courses (DSE)							
1	24		DSE-V	4/3	0	0/2	0	4	4
2	25	MMAE 0001-0004, 0006-0008, 1009, 0010-0027 /	DSE-VI	4/3	0	0/2	0	4	4
3	26	MMAE 0101-0108, 0110-0118, MCAC 0009_0807*_MCAE 0306	DSE-VII	4/3	0	0/2	0	4	4
4	27	0372; BCSE 0152, 0181	DSE-VIII	4/3	0	0/2	0	4	4
5	28		DSE-IX	4/3	0	0/2	0	4	4
Proje	ects (J)								
6	29—	MMAJ 0965	Project-IV	0	-0	0	4	4	— 4
Hum	anities a	nd Social Sciences Course (HS	SC)						
7	30	BCHS 0201	Environmental Studies	2	0	0	0	2	2

SYLLABI OF SUBJECTS

PROGRAM CORE COURSES (C)

5. COURSE-LEVEL LEARNING OUTCOMES

Course No:	1	Course Name: F	Real Analysis	5		Cours	se Cod	le: MMAC	1001	
Batch:		Programme: M.Sc.	Semester:	L	Т	Р	J	Credits	Contact Hrs Per Week:4	
2024-2026		Mathematics	Ι	3	1	0	0	4	Total Hours: 4)
Total Evalua	atio	n Marks: 100	Examinatio	on Du	iratio	n: Mid	Term	(2 hours),	End Term (3 hour	rs)
Theory Ass Internal As	essi sess	ment: 75 Marks sment: 25 Marks	Pre-requisi	te of	cours	se: N	Vil			
	Th	is course will deve	elop a profou	nd un	dersta	nding o	f coun	table and u	ncountable sets, se	auences
Course Objective	and con Fui int dev	d series of real num ntinuity and differ rther, a deep und egration will be of velopment aligned	mbers. This v rentiability a lerstanding o leveloped in with all CO'	vill a nd te of me this s	so ma st the course	ke the s unifor ole fund e. This	student m con ctions, course	ts able to pr vergence o Riemann e focuses o	rove the results of f sequences of fu integration and L on employability a	uniform inctions. ebesgue ind skill
	Δf	ter studying these	topics the str	s. ident	s will	he able	to:			
Course		11: Learn the conc 12: Understand un 13: Recognize the	ept of counta iform continue ifference	bility ity a betwe	of rear nd diff	al numb ferential pintwise	ers and bility, and 1	d converger and functio	nce of sequences. ns of several varia nvergence of sequ	bles. ience of
Outcomes		functions			, pe			•••	arengenee or sequ	
	CC	04: Apply tests for	uniform con	verge	ence.					
	CC	05: Learn function	s of bounded	varia	ation a	nd mea	surable	e functions.		
	CC)6: Determine the	Riemann and	l Leb	esgue	integral	oility o	of a functior	1.	
			COU	JRSI	E SYL	LABU	S			
Module No.					Cont	ent				Hours
I	[C Co Fu Gif Im	ourse Outcome(sountable and uncountable and uncountable and uncountable and uncountable and uncountable and the set of th	s) No.: 1 and intable sets, C iriable: Unifo eral variab ctional deriv orem, Jacobia	l 2] Conve orm c oles: vative uns, F	ergenco ontinu Limi es, Ta ubini'	e of seq ity and it, Cor ylor's s theore	uences different ntinuity series, em.	s of real nur entiability. y, Differen Inverse f	nbers. ntiability, Partial function theorem,	20
п	[C Sec cri uni Sti fur	ourse Outcome(s quence and serie terion for uniform iform convergence eltjes integration, nctions.	s) No.: 3, 4, 4 s of function convergence, Riemann i Lebesgue me	5 and ons, 1 e, W ntegr asure	16] Pointweierstration, ation, Lebe	vise and ass M-1 Functio esgue in	l unif test, A ons of tegral,	orm conve bel's and I bounded v Measurabl	rgence, Cauchy's Dirichlet's test for ariation, Riemann e sets, Measurable	20
Text Books:										
 ➢ W. R ➢ T. M 	udi I. A	n, Principles of Ma postol, Mathemati	athematical A cal Analysis,	naly: Narc	sis, Mo sa Pul	cGraw-l olishing	Hill, 20 House	017. e, 2002.		
► S. C	. Ma	alik & S. Arora, M	lathematical A	Analy	vsis, N	ew Age	Intern	national Ltd	., 2017.	
▶ R. Ba	artle	e, The Elements of	Integration a	nd L	ebesgu	e Meas	ure, W	viley Classie	cs Library, 1995.	
D. So House	oma e, 1	asundaram & B. (996.	Chaudhary, A	A Fir	st Cou	urse in	Mathe	ematical An	alysis, Narosa Pu	blishing
Reference B	ook	S:								
 ≻ K. Re ≻ H. L. ▷ P. K 	oss, Ro	Elementary Analy yden, Real Analys	vsis, The Theo is, Macmillan	ory o n Put	f Calc lishin	ulus, Sp g Comp	oringer, any, 2	, 2013. 015.		n
▶ P. K.	Jan	n & v. P. Gupta, I	Lebesgue Mea	asure	and Ir	negratio	on, Nev	w Age Inter	national Ltd., 2020	J.

Course No: 2 Course Name: Abstract Algebra Course Code: MMAC 1002										
Batch:	Progra M	mme: I.Sc.	Semester:	L	Т	Р	J	Credits	Contact Hrs Per Week:4	
2024-2026	Math	ematics	Ι	3	1	0	0	4	Total Hours: 4	0
Total Evalu	ation Marks	s: 100	Examinatio	on Dı	iratio	n: Mid	Term	(2 hours), E	End Term (3 hour	rs)
Theory Ass Internal As	essment: 75 sessment: 2	5 Marks 5 Marks	Pre-requisi	te of	cours	e: N	Jil			
	This course	will dev	elop a profou	ind ur	ndersta	unding o	of grou	p action and	l classification of	groups.
Course	This will m	hake the s	tudents able	to pr	ove th	e result	s base	d on compo	sition series, com	mutator
Objective	subgroups a	and solva	bility of grou	ıps. Т	This co	ourse w	ill also	provide the	e knowledge of r	nodules,
0	field extens	ions and	Galois group	s. Th	is cou	rse focu	ises on	employabil	ity and skill deve	lopment
	aligned with	h all CO's	5.							
	After study	ing these	topics, the stu	ıdent	s will l	be able	to:			
	CO1: Learn	n the cond	cept of intern	al an	d exter	rnal dire	ect pro	ducts and us	se them to unders	tand the
	grou	p action a	nd classificat	tion o	f grou	ps.				
Course	CO2: Unde	erstand co	mposition set	ries, c	commu	itator si	ıbgrou	ps and solva	bility of groups.	
Outcomes	CO3: Knov	v the conc	cept of modul	les, ar	nd Noe	etherian	and A	rtinian rings.		
	CO4: Dete	rmine the	e field exten	sions	and u	use then	n in f	inding of sp	olitting fields and	l Galois
	grou	ps.								
			COU	JRSE	E SYL	LABU	S			
Module No	•				Cont	ent				Hours
Ι	Group The Conjugacy Cauchy's orders p^n , point Nilpotent g Solvable gi $S_n (n \ge 5)$.	eory: Inte classes, (theorem $q, p^2 q$ an roups, Co roups, Ne	ernal and Extension Extension Class equation $d p^2 q^2 (n > p)$ composition second excessary and	ernal on of 's 1, p a eries, suffi	direct a gro theor nd q a Jordan cient o	produc up, Au em, re prim 1-Holde conditic	ts and tomorp Simples). er theo ons for	their relation phisms, Inne licity of rem, Commun solvability,	ns, Group action, er automorphism, groups of utator subgroups, Insolvability of	20
п	[Course O Ring Theo Noetherian Fields: Ex Separable Fundamenta	utcome(s ry: Modu and Artin tension f extension al theoren	s) No.: 3 and iles, Simple a iian rings and ields, Algeb , Normal ex n of Galois th	1 4] and S their raic stensi eory.	emi-si identi and T on, Po	mple ri ty. ranscer erfect 1	ngs, S ndental field,	chur's lemm extension, finite fields,	a, Free modules, Splitting fields, , Galois groups,	20
Text Books										
➢ J. A.	Gallian, Cor	ntemporar	ry Abstract A	lgebr	a, Bro	oks/Col	e, Cen	gage Learnii	ng, 2010.	
➤ I. N.	Herstein, To	pics in A	lgebra, John	Wiley	v & So	ns, 200	6.			
➢ C. P.	Milies & S.	K. Sehga	l, An Introdu	ction	to Gro	oup Rin	gs, Klı	uwer Acader	nic Publishers, 20	002.
Reference E	looks:									
► V. K	. Khanna & S	S. K. Bha	mbri, A Cour	rse in	Abstra	act Alge	ebra, V	ikas Publish	ing House, 2016.	
≻ F. W	. Anderson &	& K. R. F	uller, Rings a	nd Ca	ategori	es of M	Iodules	s, Springer-V	/erlag, 1992.	
> D. S	Dummit &	R. M. Foo	ote, Abstract	Algeł	ora, W	iley, 20	03.			
➢ P. B 1994	Bhattachary	ra, S. K. J	ain & S. R. N	lagpa	ul, Bas	sic Abs	tract A	lgebra, Cam	bridge University	Press,

Course No:	3	Course Name: Ord	inary Differential E	Equation	ons	Cour	rse C	Code: MM	AC 0003	
Batch:		Programme: M.Sc.	Semester:	L	Т	Р	J	Credits	Contact H Per Week	rs :4
2024-2026		Mathematics	Ι	3	1	0	0	4	Total Hou	rs: 40
Total Evalu	atio	Marks: 100	Examination Du	ration	: Mi	d Ter	m (2	hours), E	nd Term (3	hours)
Theory Ass Internal As	sessn sess	nent: 75 Marks ment: 25 Marks	Pre-requisite of	course	2:	Nil				
Course	Thi	s course will develo	op a profound und	lerstan	ding	for f	indin	ig the sol	lution of n	th order
Objective	diff	erential equations. T	his course will als	o mak	the the	e stuc	lents	able to f	ind the sol	ution of
	bou	indary value problem	s and analyze the sta	bility	of dy	namic	al sy	stems. Th	is course fo	cuses on
	em	ployability and skill d	evelopment aligned	with a	11 CC	's.				
	Aft CO	er studying these topi 1: Understand initia	cs, the students will and boundary va	be abl	e to: oblei	ns ar	ıd fii	nd the so	lution of n	th order
Course		homogeneous and	non-homogeneous d	ifferer	tial e	auatio	ons.			
Outcomes	CO	2: Determine the Eig	en values and Eigen	functi	ons a	nd lea	arn th	eir applica	ations.	
	CO	3: Construct Green's	function for the solu	ution o	f bou	ndary	valu	ie problem	IS	
	CO	4: Find the stability of	of linear and non-line	ear dyr	namic	al svs	stems			
	00		COURSE SYI		US	ui sys		·•		
Module No	•		Con	tent						Hours
I	[Co Intr solu met ord valu theo	ourse Outcome(s) N roduction, Initial and ations of ordinary di- thod, Existence and U er, Strum-Liouville 1 ues and Eigen funct- orems.	o.: 1 and 2 d Boundary value fferential equation of Jniqueness theorem boundary value pro- tions, Eigen functio	proble of first for or oblem, n expa	ems, orde dinar Orth nnsion	Exist er, Lip y diff ogona 1s, Se	ence oschi erent al set epara	and Unitic tz conditionial equation ts of func- tion and of	iqueness of on, Picard's on of higher ction, Eigen Comparison	20
II	[Co Gree bou Criv stat plan syst	burse Outcome(s) Neen's functions, Consumdary value problem tical point of an automole and strictly stable ne autonomous systemes.	6.: 3 and 4] truction of Green's ns, Stability of auto nomous system and e. Stability of linea em, Perturbed syst	funct onomo their c r syste em, M	ion a us sy lassif em w Ietho	nd its ystem ficatio rith co d of	s app of c n as onsta Lyaj	blication t lifferentia stable, asy nt coeffic punov for	o solve the l equations, mptotically ient, Linear non-linear	20
Text Books:). Ra Sha . Coo	isinghania, Ordinary rma & R. K. Gupta, D ldington & N. Levins	Differential Equatio Differential Equation on, Theory of Ordin	ns, S. (s, Kris ary Di	Chano hna F fferei	l & C Prakas ntial E	o., 20 han 1 Equat	019. Media (P) ions, McG	Ltd., 2019. Fraw Hill, 20)17.
Reference B > G. B >-S. L. > W. F John > P. H	Books irkho -Ros E. Bo Wile artm	s: off & G. C. Rota, Ord s, Differential Equation byce & R. C. Di Prin ey and Sons Inc., 200 an Ordinary Different	inary Differential Econs, John Wiley and na, Elementary Dif 9. tial Equations John	quation Sons ferentia Wiley	ns, Jo Inc., 1 al Eq & Se	hn Wi 1984. uation	iley a	nd Sons I d Bounda	nc., 1989. ry Value Pi	roblems,
📕 Г. П	arulli	an, Orumary Differen	uai Equations, John	wney	a 30	лія, 1	902.			

Course No:	ourse No: 4 Course Name: Linear Algebra Course Code: MMAC 1004								
Batch:	Programme	: Semester:	L	Т	Р	J	Credits	Contact Hrs/w	eek: 4
2024 2026	M.Sc.	I	3	1	0	0	4	Total Hours: 4	0
2024-2026 Total Evalue	Mathemati	cs							
I Utal Evalua	11011 1v1a1 KS: 100	Examinatio	on Di	iratio	n: Mid	Term	(2 hours), I	End Term (3 hour	rs)
Theory Asso Internal Ass	essment: 75 Mar sessment: 25 Ma	ks rks Pre-requisi	te of	cours	se: N	Jil			
	This course will	develop a profe	ound	under	standing	g of m	natrices, dec	composition meth	ods and
Course Objective	quadratic forms. product spaces. F will be develope aligned with all C	This course will Further, a deep un d in this course. CO's.	mak iderst This	e the s anding cours	tudents g of ana e focus	able t lysis m ses on	o understan nethods to so employabili	d vector spaces a plve the real life p ity and skill deve	nd inner problems lopment
Course Outcomes	After studying the CO1: Understand CO2: Apply Gra CO3: Know the I CO4: Understand CO5: Develop pr CO6: Compute g CO7: Apply the CO8: Extract inf canonical c	ese topics, the stu d the concept of w m-Schmidt ortho linear transforma d the concept rela roblem solving te g-inverses by diffi- concept of sparse ormation from da orrelation analys	ident vector gona tion a ated to child erent e mata ata by is.	s will l r space lization and its o defin ques fo metho rices ir v using	be able and its n process matrix niteness or decorr ods. n solvin the cor	to: applic ss for (represe of mat npositi g real 1 ncepts	cation in stat QR decompo- entation. rices and re on of matric life problem of linear dis	tistics. osition. lated results. ces. s. criminant analysis	s and
		CÓU	JRSI	E SYL	LABU	S			
Module No.				Cont	ent				Hours
I	[Course Outcor Vector spaces, Su and dimension, I transformation, F spaces, Orthogon	ne(s) No.: 1, 2 a ubspaces, Linearl Linear transforma Rank-nullity theo al sets, Gram-Sc	nd 3 ly dep ation, orem, hmid] benden Kerne Eigen t ortho	t and in al, Rang values gonaliz	ndepen ge, Mat s and l ation p	dent sets, Sj trix represer Eigen vecto process.	panning set, Basis ntation of a linear rs, Inner product	20
Ш	[Course Outcor Quadratic forms, form, Diagonal equations, Spectr Applications in inverses, Genera discriminant anal	ne(s) No.: 4, 5, 6 Definiteness an form, Triangular al decomposition Statistics: General solution to a ysis and Canonic	6, 7 and rel and rel r form ralize syste cal co	and 8] ated r m, Ga gular v d inve m of rrelatio	esults. uss-Jore value de rses (g- linear o on analy	Gauss dan-LU compo inverse equationysis.	Elimination J decomposition. e), Method ons, Sparse	n, Row canonical sition, System of of constructing g- matrices, Linear	20
Text Books:	1								<u>. </u>
 D. A. D. C. 	Harville, Matrix Lay, S. R. Lay &	Algebra from a S J. J. McDonald,	Statist Line	ician's ar Algo	s Perspe ebra and	ective, d its Aj	Springer, 19 pplications,	997. Pearson, 2023.	
Reference B ≻ K. M ≻ C. D	ooks: I. Abadir & R. Ma . Meyer, Matrix A	ngnus, Matrix Alg Analysis and App	gebra lied I	, Caml	oridge U <u>Alge</u> bra	Jnivers 1 <u>, SI</u> AN	sity Press, 2 M, 2000.	006.	

C. D. Meyer, Matrix Analysis and Applied Linear Algebra, SIAM, 2000.

Course No: :	Durse No: 5 Course Name: Statistical Analysis Course Code: MMAC 1005									
Batch:	Programme: M.Sc.	Semester:	L	Т	Р	J	Credits	Contact Hrs Per Week:4		
2024-2026	Mathematics	Ι	3	1	0	0	4	Total Hours: 4)	
Total Evalua	ation Marks: 100	Examinatio	on Du	iratio	n: Mid	Term	(2 hours), H	End Term (3 hour	rs)	
Theory Asso Internal Ass	essment: 75 Marks sessment: 25 Marks	Pre-requisi	te of	cours	se: N	[il				
	This course will dev	elop a profo	und ı	unders	tanding	of var	rious statisti	cal methods whi	ch can be	
Course	applied on data ana	lysis and ot	her r	eal pr	oblems	This	will also 1	nake the student	s able to	
Objective	understand probabil	ity distribut	ions	and	apply	on re	al data pr	oblems. Further,	a deep	
U U	understanding of test	ting of hypot	hesis	will	be deve	loped	in this cour	se. This course for	ocuses on	
	employability and sk	ill developme	ent al	igned	with all	CO's.				
	After studying these	topics, the stu	ıdent	s will	be able	to:				
	CO1: Understand the	e basic conce	pts of	f statis	tical and	alysis,	variables, d	ata and measures	of central	
Course	tendency and o	dispersion.	_							
Course	CO2: Apply the meth	hods to actua	l qua	ntitativ	ve data a	and inte	erpreting the	e results of the		
Outcomes	analysis.				1		1.			
	CO3: Perform correl	ation and reg	ressi	on ana	lysis of	given	data.			
	CO4: Learn the conc	ept of probat	oility	and pr	obabilit	y distr	ibutions.		1.1	
	COS: Understand me	ethods of esti		on and	apply ti	ie testi	ng of nypot	nesis on various p	oroblems.	
Modulo No	COURSE SYLLABUS									
	[Course Outcome($(\mathbf{v}) \mathbf{N} \mathbf{o} \cdot 1 2 \mathbf{o}$	nd 2		CIII				Hours	
	Introduction to Stat	5) INU.: 1, 4 a tistical Analy	nu J	J What	ie etatie	tice? T	where of stat	istics Population		
	vs Sample Basic terr	ninology Me	y 515. 9351174	ement	& Scali	ng ch	aracteristics	istics, i optitation		
Ι	Types of Variables	Nominal	and	Ordin	al Inter	rval &	r Ratio sca	les. Quantitative	20	
	variables. Qualitativ	e or catego	orical	varia	ables. (Contini	uous and	Discrete random		
	variables.									
	Data : Sources of data	a, Cross-secti	on da	ata, Tii	me-serie	es data.				
	Measures of central	tendency an	d Di	spersio	on, Posi	tion g	uartiles, Int	er-Quartile range		
	and Percentiles. Freq	uency distrib	ution	s (rela	tive, cui	nulativ	ve).			
	Correlation and Re	gression Ana	lysis	: Cova	riance,	Karl P	earson's con	relation		
	coefficient, Rank cor	relation, Out	iers,	Regre	ssion.					
	[Course Outcome(s	s) No.: 4 and	15]							
	Analysis of Varianc	e (ANOVA):	One	way a	nd two-	way cl	lassification	•		
п	Probability Distribu	tions: Binon	nial, l	Poisso	n and N	ormal	distribution	8.	20	
11	Statistical Inference	e: Unbiasedr	less,	Suffic	iency, 1	Metho	ds of Estim	ation (MLE and	20	
	method of moments),	, Interval esti	matic	on.						
	Testing Hypothesis	: Population	dist	tributio	on, San	npling	and Non-S	Sampling Errors,		
	Testing of hypothesis	5.				-				
	The t- distribution:	t-test for sing	gle mo	ean, t-	test for o	differe	nce of mean	, paired t-test.		
	The F- distribution:	F-test for eq	uality	y of po	pular va	ariance	es.			
	Chi-squared goodnes	s-of-fit test, (Chi-s	quare 1	test of in	ndepen	dence.			

Text Books:

- S. C. Gupta & V. K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand and Sons, 2014.
- ▶ G. J. Kerns, Introduction to Probability and Statistics Using R, Lulu.com, 2014.

Reference Books:

- D. C. Montgomery & G. C. Runger, Applied Statistics and Probability for Engineers, Wiley India, 2013.
- A. M. Mood, F. A. Graybill & D. C. Boes, Introduction to the Theory of Statistics, Tata McGraw-Hill, 2017.
- > H. A. David & H. N. Nagaraja, Order Statistics, John Wiley & Sons, 2003.

Course No: 6 Course Name: Operational Research-I Course Code: MMAC 1006											
Batch:	Programme: M.Sc.	Semester:	L	Т	Р	J	Credits	Contact Hrs Per Week:4			
2024-2026	Mathematics	II	3	1	0	0	4	Total Hours: 4	0		
Total Evalua	ntion Marks: 100	Examinatio	on Du	iratio	n: Mid	Term	(2 hours), l	End Term (3 hour	rs)		
Theory Asse Internal Ass	essment: 75 Marks sessment: 25 Marks	Pre-requisi	ite of	cours	e: N	lil					
Course Objective	This course will dev problems. The studer decision problems. F developed in this con with all CO's.	elop a profents will learr aurther, a dee aurse. This co	ound 1 opti 2p und ourse	unders mal de derstan focuse	tanding ecision Iding of es on er	g of lin policy f non-l mploya	near and int and will be inear progra ability and s	teger linear progr e able to solve m amming problems skill development	amming ultistage will be aligned		
Course Outcomes	After studying these to CO1: Solve various lo CO2: Find solution of CO3: Learn the math CO4: Understand no	opics, the str inear program of integer line ematical too nlinear progr	udent mmin ear pr ls to s camm	s will t og prob ogrami solve p ing pro	be able lems. ming ar roblem bblems	to: nd sequ s on dy and me	encing prol ynamic prog thods to ob	blems. gramming. tain their solution	s.		
Modulo No	CO4: Orderstand nominear programming problems and methods to obtain their solutions. COURSE SYLLABUS										
) No . 1	1 01	Cont	ent				110015		
Ι	Linear Programmin artificial variable – method, Sensitivity a Integer Linear Pro problems, cutting pla Sequencing Problem two machines and n	ng Problem Big M meth nalysis. gramming I ne method, E n: Introduction	s (Ll hod a Probl Branch on, As	PP): In and Ty lems: h and b ssumpt	ntroduc vo pha Introdu oound n ions, Jo	ction, S se me ction, nethod ohnson	Simplex me thod, Duali mixed inte .'s procedur machines	ethod, Method of ty, Dual simplex ger programming e for njobs on	20		
п	[Course Outcome(s Dynamic Program Bellmann principle of certainty, Approach f Non Linear Program Convex Functions, So constraints using Kul	c) No.: 3 and ming: Intro of optimality or solving Ll mming Prob plution of NI an-Tucker co	1 4] oduct 7, Mu PP. lems LPP h nditio	ion, iltistag (NLPI aving ons, Mo	Ferming e decis P):Intro one and ethod o	ology, ion pr oductio l more f Lagra	Optimal oblems, Pro n, Formulat than one ind	decision policy, ogramming under ion, Concave and equality liers.	20		
Text Books: ▶ P. K. ▶ J. K. ▶ K. Sw	Gupta & D. S. Hira, C Sharma, Operations R varup, P. K. Gupta & D	Dperations R esearch Theo M. Mohan, C	esear ory an Opera	ch, S. (nd App tions R	Chand & lication	& Co., 1s, Mac 1, Sulta	2015. cmillian Ind an Chand &	ia Ltd., 2017. Sons, 2014.	<u> </u>		
Reference B ▶ S. D. ▶ H. A. ▶ D. C.	ooks: Sharma, Operations F Taha, Operations Res Sanyal & K. Das, Lir	Research, Ke search: An In sear program	dar N htrodu ming	ath & l ction, and G	Ram Na Pearson ame Th	ath Pul 1 Educ 1eory, U	olications, 2 ation, 2014. U. N. Dhur	012. & Sons (P) Ltd., 2	2020.		

Course No:	7 Course Name: '	Topology			Cours	e Cod	e: MMAC	0007	
Batch:	Programme: M.Sc.	Semester:	L	Т	Р	J	Credits	Contact Hrs Per Week:4	
2024-2026	Mathematics	II	3	1	0	0	4	Total Hours: 4	0
Total Evalua	ation Marks: 100	Examinatio	on Du	iratio	n: Mid	Term	(2 hours), l	End Term (3 hour	rs)
Theory Asso Internal Ass	essment: 75 Marks sessment: 25 Marks	Pre-requisi	ite of	cours	e: N	lil			
Course Objective	This course will dev and metrizable space axioms and separati employability and sk	elop a profou es. Further, a ion axioms ill developmo	und u a deej will ent al	ndersta p unde be de igned v	anding erstandi velopec with all	of topo ng of l in th CO's.	ological spa connected, nis course.	aces, continuous fr compact and cou This course foc	unctions ntability uses on
Course Outcomes	After studying these CO1: Understand top CO2: Determine the CO3: Learn continuo CO4: Characterize th CO5: Know separati	topics, the str pology, topol nature of dif- ous maps and the connected, on axioms ar	udent ogica ferent unde , com nd bas	s will b l space t points erstand pact ar sic proj	be able es and to s of a se produc nd coun perties.	to: opolog et. t, quot table s	y generated ient and me paces.	by basis and sub	basis.
		COU	JRSI	E SYL	LABU	S			
Module No.				Cont	ent				Hours
I	[Course Outcome(s Topological spaces, points, Isolated poi Boundary points of a Homeomorphism, Pr Metrizable space, Qu	s) No.: 1, 2 a Basis and S nts, Derived set, Subspac roduct topolo totient topolo	and 3 Sub b l sets res, C ogy, 1 ogy.] asis, C s, Den ontinui Produc	Ordered use sets ity and t of to	topolo s, Clos Relateo pologio	ogy, Limit sure, Interi d results, Tl cal spaces,	points, Adherent or, Exterior and ne Pasting lemma. Metric topology,	20
Ш	[Course Outcome (s Connected and Discomponents, totally c Compact spaces, L compactness, First a $T_0, T_1, T_2, T_3, T_{3^{1/2}}, T_{3^{1/2}}$	s) No.: 4 and sconnected s lisconnected limit point nd Second c Γ_4 spaces, Ch	1 5] spaces space comp ounta aracte	s, Con es, loca bact a ble sp erizatio	nponen Illy con nd sec aces, S ons and	ts, Pa nected luentia eparab basic j	th connect spaces. Ily compac le space, So properties.	ted spaces, Path ct spaces, Local eparation axioms:	20
Text Books: ▶ J. R. ▶ G. F. ▶ J. N.	Munkres, Topology, A Simmons, Introductic Sharma & J. P. Chauł	A First Cours on to Topolog nan, Topolog	e, PH gy and y (Ge	I, 2000 1 Mode neral a). ern Ana ind Alg	llysis, l ebraic)	McGraw-Hi), Krishna P	ill Inc., 2017. rakashan, 2019.	L
Reference B ≻ J. L. 1 ≻ -K. D.	ooks: Kelley, General topolo Joshi, An introductio	ogy, Springer on to general	r Verl topol	ag, 20 ogy , W	17. 'iley Ea	stern I	.td., 2017.		

Course No:	e No: 8 Course Name: Functional Analysis Course Code: MMAC 0009									
Batch:		Programme: M.Sc.	Semester:	L	Т	Р	J	Credits	Contact Per We	Hrs ek:4
2024-2026		Mathematics	II	3	1	0	0	4	Total H	ours: 40
Total Evalua	ation	Marks: 100	Examination 1	Duration	: Mid Te	rm (2 h	ours),	End Tern	n (3 houi	s)
Theory Asso Internal Ass	essm sessr	ent: 75 Marks nent: 25 Marks	Pre-requisite	of course	e: Nil					
Course	This	s course will de	velop a profour	nd unders	tanding c	of norm	ed lin	ear spaces	s. This c	ourse also
Objective	inclu	udes bounded, 1	unbounded and	closed	operators,	orthor	ormal	basis an	d their	properties.
	Furt	her, a deep unde	rstanding of star	ndard theo	orems and	their a	oplicat	ions will t	e develo	ped in this
	cour	se. This course t	focuses on empl	ovability	and skill o	levelop	ment a	ligned wit	h all CO	'S.
	Λfte	or studying these	topics the stude	nte will h	e able to:					
	CO	1 Studying these 1 · Understand Ba	anach and Hilber	nts will U	and stand	ard theo	orems (lefined on	these sn	aces
Course	CO'	2. Differentiate h	ounded unbour	nded and c	losed one	ard the			these sp	aces
Outcomes	CO	3: Check converg	pence of operato	rs by usin	g a suitab	le norm	and c	ompute th	e dual sp	aces
	CO4	4: Find orthonorr	nal basis and lea	arn its apr	lications			omp <i>uu</i> m	- unui sp	
	CO	5: Apply uniform	n boundedness t	heorem, o	pen mapp	ing theo	orem a	nd closed	graph the	eorem
			COUI	RSE SYI	LABUS					
Module No.				Conte	ent					Hours
	[Co	urse Outcome(s	s) No.: 1, 2 and	l 3]						
	Nor	med linear space	s, Banach space	s, Hilbert	Spaces a	nd basi	c prop	erties, Hei	ne Borel	
	theo	orem, Riesz len	nma and best	approxin	nation pr	operty.	Inner	product	spaces.	
Ι	Proi	ection Theorem	. Bounded ope	erators. S	pace of	bounde	d ope	rators. un	bounded	20
	oner	ators Riesz repr	esentation theor	em Conv	vergence (of seque	ence of	onerators	Closed	
	oper	ators, Riesz Tepi	esentation theor	ciii, coiiv	l'engeniee (JI seque		operators	, C103Cu	
	oper	ator.								
	[Co	urse Outcome(s	s) No.: 4 and 5]						
II	Orth	nonormal bases,	Bassel inequalit	ty and Pa	rseval's F	Formula	Riesz	Fischer	theorem,	
	Hah	n Banach extensi	on theorem Un	; iform bor	indedness	princip	le Clo	sed graph	theorem	
	and	Open mapping th	eorem Applica	tions	inacaness	princip	10, 010	sea graph	lineoreni	20
	and	open mapping u	icorem, ripplied	atons.						
Text Books										
 M. T. B. V. G. F. 	. Nain Lim Simi	r, Functional Ana aye, Functional A mons, Introductio	alysis, A first co Analysis, New A on to Topology a	urse, PHI Age Intern and Mode	, 2001. ational, 20 rn Analys	014. is, McC	braw-H	lill, Inc. 20	017.	
Reference R	ooke	•								

- E. Kreyszig, Introductory Functional Analysis with Applications, John Wiley and Sons, 2007.
- A. H. Siddiqi, K. Ahmad & P. Manchanda, Introduction to Functional Analysis with Applications, Anamaya Publishers, 2007.
- G. Bachman & L. Narici, Functional Analysis, Dover Publications, 2012.
- > J. B. Conway, A Course in Functional Analysis. Springer, 2010.

Course No:	9 Course Name:	Partial Differe	ential Equ	ations-I	Cours	e Cod	e: MMA	C 1010	
Batch:	Programme: M.Sc.	Semester:	L	T	Р	J	Credits	Contact Per We	Hrs æk:4
2024-2026	Mathematics	III	3	1	0	0	4	Total H	ours: 40
Total Evalu	ation Marks: 100	Examination	Duration	n: Mid Te	rm (2 h	ours),	End Terr	n (3 hou	rs)
Theory Ass Internal As	essment: 75 Marks sessment: 25 Marks	Pre-requisite	of course	e: Ordina	ry Diffe	rentia	l Equation	ns	
	This course will dev	elop a profoun	d understa	anding of	initial a	nd bo	undary va	alue prob	lems, heat
Course	Laplace and wave eq	uations and the	ir solutior	s. This co	urse als	o inclu	ides the fi	rst order	hyperboli
Objective	equations and class	sification of se	econd or	ler partia	l differ	ential	equations	s. Furthe	r, a dee
	understanding of m	ethod of separ	ation of v	variables (to find	the so	olution of	partial o	differentia
	equations will be o	leveloped in th	nis course	This co	ourse fo	cuses	on emp	lovability	and skil
	development aligned	with all CO's		. 11115 00		cuses	on emp	loyuonny	und skii
		with all CO s.	11.1	1. 1					
	After studying these	topics, the stud	ents will b	e able to:					
Course	CO1: Solve first ord	er nyperbolic e	juations.	ntial agree	iona				
Outcomes	CO2: Classify the se	cond order part	al amere	ntial equal	nd relat	ad tam	20		
outcomes	CO3: Understand in	as of Laplace h	if y value p	avo oquoti	one and	moth	IIS. Inde to find	thair cal	utions
	CO5: Know method	of separation of	f variables	ave equali	ons and	ifforor	tial equat	i uleli sol	utions.
	CO3: Know method				partial u	merer	illai equal	.10115.	
									тт
Module No.	•		Conte	ent					Hours
	[Course Outcome(s) No.: 1, 2, 3 a	and 4]						
	Introduction, Cauch	y's method of	character	ristics for	solving	g first	order h	yperbolic	
	equations, Classifica	tion of second	order par	rtial differ	ential e	quatio	ons, Norm	hal forms	
Ι	and characteristics.								20
	Initial and Bounda	ry Value Prob	lems: Lag	range-Gre	een's id	entity	and uniqu	ieness by	
	energy methods.								
	Stability theory, ener	gy conservation	n and disp	ersion.					
	Laplace equation: N	Aean value proj	perty, Wea	ak and Stro	ong max	timum	principle	, Green's	
	function, Poisson's	formula, Dirich	let's princ	iple, Exis	tence of	f solut	ion using	Perron's	
	method (without pro	of).							
	[Course Outcome(s) No.: 4 and 5	5]						
	Heat equation: In	itial value pro	oblem, Fu	undamenta	al solut	ion, V	Weak and	d Strong	
	maximum principle a	and Uniqueness	results.						•
II	Wave equation: Un	niqueness, D'A	lembert's	method,]	Method	of sp	herical m	eans and	20
	Duhamel's principle								
			' 1 <i>i</i> T	1 1		anatio	nc		
	Methods of separation	on of variables f	or heat, L	aplace and	wave e	quality	115.		
Text Books:	Methods of separatio	on of variables f	or heat, La	aplace and	i wave e	quuito	115.		
Text Books: ≻ L. C.	Methods of separation	on of variables f	or heat, La	te Studies	in Math	emati	cs), AMS	, 2014.	
Text Books: → L. C. → I. N.	Methods of separation Evans, Partial Difference Snedden, Elements of	on of variables f ential Equations Partial Differe	or heat, La : (Gradua ntial Equa	te Studies	in Math er Publie	nemations	cs), AMS, 5, 2006.	, 2014.	
Text Books: → L. C. → I. N. → H. F	Methods of separation Evans, Partial Difference Snedden, Elements of F. Weinberger, A Fi	n of variables f ential Equations Partial Differe rst Course in	or heat, La s: (Gradua ntial Equa Partial D	te Studies tion, Dove ifferential	in Math er Public Equati	nemations cations on: w	cs), AMS s, 2006. ith Comp	, 2014. plex Var	iables an
Text Books: → L. C. → I. N. → H. F Tran	Methods of separation Evans, Partial Difference Snedden, Elements of F. Weinberger, A Fi sform Methods, Dove	on of variables f ential Equations Partial Differe rst Course in r Publications, 2	or heat, La s: (Gradua ntial Equa Partial D 2012.	te Studies tion, Dove ifferential	in Math er Public Equati	emations cations on: w	rs), AMS, s, 2006. ith Comp	, 2014. plex Var	iables and

P. V. O'Neil, Advanced Engineering Mathematics, Cengage Learning Custom Publishing, 2011.
 M. D. Raisinghania, Advanced Differential Equation, S. Chand Publishing, 2018.

Course No: 1	Se No: 10 Course Name: Numerical Analysis Course Code: MMAC 1013									
Batch:		Programme: M.Sc.	Semester:	L	Т	Р	J	Credits	Contact Per We	Hrs ek:4
2024-2026		Mathematics	III	3	1	0	0	4	Total H	ours: 40
Total Evalua	tion I	Marks: 100	Examination 1	Duration	: Mid Te	rm (2 h	ours),	End Tern	n (3 hou	s)
Theory Asse Internal Ass	essme essm	nt: 75 Marks ent: 25 Marks	Pre-requisite	of course	: Nil					
Course Objective	This c acqua algeb tridiag nume	course aims to g int the student raic and trans gonalization and rical solutions of opment aligned	ive exposure to s with a wide cendental equa d decomposition f partial differe with all CO's	some adv range of ations, lin n of a ma ntial equa	anced nur advanced near syst trix and r tions. Thi	merical l numer em of mainly s s course	metho ical n equat some t focus	ds. The control of th	ourse objo o solve s ference erence m ployabilit	ective is to systems of equations, ethods for y and skill
Course Outcomes	After CO1: CO2: CO3: CO4:	studying these t clearn numeric equations and Solve difference Understand fin especially heat Familiarize the	some curve fitti e equations and ite difference m Laplace and P students with a	ents will be find the n ing proble d decompo- nethods fo Poisson equadvantages	e able to: umerical ms. ose a matri r numeric uations. s and limit	solution ix. al soluti tations c	s of sy ons of	ystem of 1 f partial di erical tech	inear and fferential miques.	nonlinear equations
	[COUI	RSE SYL						
Module No.				Conte	nt					Hours
I	Errors and it for cc House Diffe functi	s in numerical of s sufficient con- omplex roots, No eholder method rence Equation ions.	computation, Fi dition for conve ewton-Raphson for tridiagonalizes: Introduction	xed point ergence, C method, S zation of s , Solution	iterative hebyshev Spline inte symmetric of differe	method method erpolatic matrix. ence eq	for th , Lin- on, uation	e system Bairstow's s using ge	x = g(x) s method enerating	20
	Matr	ix Decompositi	on: QR method	, Singular	value dec	composi	tion (S	SVD) of a	matrix.	
п	[Cou Boun points Num by po (SOR Bende	rse Outcome(s dary Value P s, Standard and erical Solution bint Jacobi's me) method, Pois er-Schmidt expl	b) No.: 3 and 4 roblems: Finit Diagonal five pr of Partial Differt thod, Liebmann sson's equation icit finite differt] e differen oint formu erential F n's iteration n and its ence scher	nce appro ilae, Finit C quations on process solution. me.	oximatio e differe : Solution and Su Solution	n to ence m on of l accessi n of l	derivative hethod. Laplace's ve over-ra heat equa	equation equation elaxation tions by	20
Text Books:	Gupta kinsor oyal, C Sastry	a, Numerical Me n & W. Han, Th Computer Based y, Introductory M	ethods: Fundam eoretical Nume Numerical and Iethods of Num	entals and rical Anal Statistical erical Ana	Applicat ysis, Sprin Techniqu llysis, PHI	ions, Ca nger Sci es, Univ I, 2012.	mbrid ence & versity	ge Univer & Busines Science P	rsity Press s Media, ress, 2017	s, 2019. 2010. 7.
Reference Bo M. K. New A G. D. Unive B. Bra	Jain, Jain, Age In Smit ersity I adie, A	S. R. K. Iyenga ternational Publ h, Numerical so Press, 1985. A friendly introd	r & R. K. Jain, I ishers, 2019. Dution of Parti- uction to Numer	Numerical al Differe ical Analy	Methods ntial Equa	for Scie ations: 1 on Educa	ntific a Finite ation, 2	and Engine Difference 2007.	eering Co	omputation, ls, Oxford

Course No:	11 Course Name: (Complex Ana	lysis		Cours	e Cod	le: MMAC	0014				
Batch:	Programme: M.Sc.	Semester:	L	Т	Р	J	Credits	Contact Hrs Per Week:4				
2024-2026	Mathematics	III	3	1	0	0	4	Total Hours: 4	0			
Total Evalua	tion Marks: 100	Examinatio	on Du	iratio	n: Mid	Term	(2 hours),]	End Term (3 hour	rs)			
Theory Asse Internal Ass	essment: 75 Marks sessment: 25 Marks	Pre-requisi	te of	cours	e: N	Vil						
	This course will dev	elop a profe	ound	unders	standing	g of re	esidues to e	evaluate complex	contour			
Course	integrals. This will	also make th	ie stu	dents a	able to	under	stand variou	is transformations	s, steady			
Course Objective	temperatures and star	ndard theore	ms ar	nd prov	ve relat	ed resu	ults. Further	, a deep understa	nding of			
Objective	analytic continuation	will be deve	loped	l in thi	s cours	e. This	s course foc	uses on employab	ility and			
	skill development ali	gned with all	CO's	s.								
	After studying these topics, the students will be able to:											
	CO1: Learn Cauchy's residue theorem and compute complex contour integrals.											
	CO2 : Understand the concept of bilinear transformation and conformal mapping.											
Course	CO3: Transform harmonic functions and other forms.											
Outcomes	CO4: Prove standard theorems based on analytic functions and simply connected regions.											
	CO5: Understand analytic continuation and related results.											
COURSE SVI LARUS												
Module No.				Cont	ent	0			Hours			
	[Course Outcome(s	s No $\cdot 1$ and	121									
	Calculus of Residues	Application	J Dof C	auchv	's resid	ue the	orem in the	evaluation of real				
	integrals Contour	integrals T	he a	rgumer	nt prin	ciple	Inverse m	apping theorem				
Ι	Definition and exami	ples of confo	rmal	mannir	ng. Line	ear fun	nctions. Fun	ction 1/z. Bilinear	20			
	transformations, their	properties a	nd cla	assifica	tions.							
	[Course Outcome(s	$\frac{1}{3}$ No.: 3. 4 a	nd 5	1								
	Transformation of Ha	armonic func	tions,	Funct	ions z^2	and $z^{1/2}$	^{/2} , Transforr	nations $w = exp$.				
	(z) and $w = \sin z$, Op	en mapping	theor	em and	l Hurw	itz's th	neorem, Rien	mann mapping				
II	theorem, Analytic co	ntinuation, U	nique	eness o	f direct	analy	tic continua	tion, Uniqueness	20			
	of analytic continuati	on along a cu	irve, i	Power	series 1	nethod	d of analytic	continuation,				
	Schwarz reflection pr	rinciple.					•					
Text Books:									I			
➢ V. R.	. Churchill & J. W.	Brown, Co	mple	x Vari	ables a	ind Ap	pplications,	McGraw-Hill Pu	blishing			
Comp	bany, 2013.				_							
\succ S. Poi	nnusamy, Foundation	s of Complex	x Ana	lysis, ľ	Varosa	Publis	hing House,	2011.				
\rightarrow H.A.	Convey, Eurotions of	to Complex	Anai v Vo	ysis, C riabla	Tarendo Spring	on Pres	ss, 2006					
$\begin{array}{c} \mathbf{\rho} & \mathbf{J} \cdot \mathbf{B} \cdot \mathbf{V} \\ \mathbf{\rho} & \mathbf{L} \cdot \mathbf{V} \end{array}$	Ahlfors Complex Ar	alvsis McG	raw F	fill Edi	ication	2017	5.					
						, _01/						
Reference Bo	ooks:											
> S. Lai	ng, Complex Analysis	s, Springer N	ature	, 2013.								
\succ M. J.	Ablowitz & A. S.	Fokas, Cor	nplex	Varia	ables:]	Introdu	uction and	Applications, Ca	mbridge			
-Unive	ersity Press, 2003.	av Analysic	MaC	row LI	11 Edu	nation	2017					
$\sim W. R$	Copson An Introduc	ch manysis,	Theor	raw H v of Fi	inction	s of C_{i}	2017. omplex Var	iables Oxford U	niversity			
Press	, 1970.											

SYLLABI OF SUBJECTS

DISCIPLINE SPECIFIC ELECTIVE COURSES (DSE)

BOUQUET 1: MATHEMATICS

Course No:	1	Course Name:	Differential C	Geom	etry	Cours	se Cod	e: MMAE	0001	
Batch:		Programme: M.Sc.	Semester:	L	T	P	J	Credits	Contact Hrs Per Week:4	
2024-2026		Mathematics	II/III/IV	4	0	0	0	4	Total Hours: 4	0
Total Evalu	atio	n Marks: 100	Examinatio	on Di	uratio	n: Mid	Term	(2 hours), l	End Term (3 hou	rs)
Theory Ass Internal As	sessi sess	nent: 75 Marks ment: 25 Marks	Pre-requisi	ite of	cours	se: N	Jil			
Course Objective	Thi sm iso ma dev	is course will deve ooth functions. T metries of surface nifolds will be d velopment aligned	elop a profou 'he students es. Further, a leveloped in with all CO'	nd un will 1 deep this	dersta earn tl under course	nding o ne conc standing e. This	f surfa epts of g of dif course	ces, tangent f curvatures ferential fut focuses of	planes, normal fi defined on surfanctions and integran employability a	elds and aces and ation of and skil
Course Outcomes	Aft CC CC CC CC CC	ter studying these 1: Understand va 2: Identify regula 3: Understand sn 4: Solve the prob 5: Learn the con	topics, the sturious basic control of the sturious basic control of the sturious basic control of the sturious based of the study of th	udent oncep nd tau ns, cu on Ga rentia	s will ots defingent a irvatur uss ma tion an	be able ned for and norr res and i up, Wein ad integr	to: the fun nal vec isometringarten ration c	nctions of sectors and de ries of surfa map and ne on manifold	everal variables. termine orientabil ces. ormal sections s.	ity.
			COU	JRSI	E SYL	LABU	S			
Module No	•				Cont	ent				Hours
Ι	[C Funder Ur Re No R ³	ourse Outcome(nctions on Euclic ivatives, Chain r ysohn lemma, Par gular surfaces in rmal fields, Orier	s) No.: 1 and lean spaces, ule, Inverse tition of unity R^3 , Coordin ntability, Exa	1 2] Cont funct <i>i</i> , Cha ate n mple	tinuity ion the ange o eighbo s of su	, Differ eorem, f variab ourhood urfaces,	entiabi Implic les. s, Tan Level	ility, Partia it function gent vector sets of smo	l and Directional theorem, Smooth s, Tangent plane, poth functions on	20
II	[Co Sn ope Me Dif fiel the	 <i>Course Outcome(s) No.: 3, 4 and 5</i> <i>Smooth functions on surfaces, Differential of a smooth function, Gauss map, Shape operator (or the Weingarten map), Normal sections, Principal curvatures, Gaussian and Mean curvature, Theorem a Egregium, Isometries of surfaces.</i> <i>Differential manifolds, Differential functions on manifolds, Tangent spaces, Vector fields, Differential forms on manifolds, Orientations, Integration on manifolds, Stoke's theorem on manifolds.</i> 								
Text Books: ≻ A. Pi ≻ A. G	ressl ray,	ey, Elementary D Modern Different	ifferential Ge tial Geometry	comet v of C	ry, Spi urves	ringer, 2 and Sur	2001. faces v	vith Mathen	natica, CRC Press	, 2006.
Reference B ≻ M. S	book piva	s: k, Calculus on Ma	anifolds: A N	loder	n App	roach to	o Class	ical Theore	ms of Advanced C	Calculus

- Westview Press, 1971.
- > J. R. Munkers, Analysis on Manifolds, Westview Press, 1997.

Course No:	2	Course Nam	e: Special R	elativ	vity	Cours	se Cod	le: MMAE 0	002	
Batch:		Programme:	Semester:	L	Т	Р	J	Credits	Contact Hrs	
		M.Sc.	II/III						Per Week:4	
2024-2026		Mathematics		4	0	0	0	4	Total Hours: 4	0
Total Evalua	ation I	Marks: 100	Examinatio	on Du	ıratio	n: Mid	Term	(2 hours), E	nd Term (3 hou	rs)
Theory Ass	essme	nt: 75 Marks	Pro-roquisi	ite of	cours	so. N	J;1			
Internal As	sessm	ent: 25 Marks	i i e-i equisi	ite of	cours	. .	11			
Course	This	course will d	evelop a pr	ofou	nd un	derstan	ding o	of special th	neory of relativ	rity and
Objective	relati	vistic mechani	cs. This cou	irse f	ocuses	s on en	nploya	bility and sk	till development	aligned
	With a	all CO's.	4 41	41		11 1 1-	1. 4			
	After	studying these	ics of Einste	in's s	nts W1	II be ab	$r_{\rm rot}$	otivity		
Course	CO1	Compute trans	sformation e	nn s s anati	ons	l theory	01 101	ativity.		
Outcomes	CO_2	Calculate ener	rgy momenti	im te	ensor					
	CO4:	Understand G	auge transfo	rmati	ion in	tensor	form.			
				JRSF	ESYL	LABU	S			
Module No.					Cont	ent	~			Hours
	[Cou	rse Outcome(s	s) No.: 1 and	2]						
	Inertial frames. Speed of light and Galilean relativity. Michelson-Morley									
	experiment. Postulates of special theory of Relativity Lorentz transformation									
Ι	equations and its geometrical interpretation. Group properties of Lorentz									
	transformations, Composition of parallel velocities. Length contraction Time									
	dilation Geometrical representation of space-time. Four dimensional Minkowskian									
	space time of spacial relativity. Time like light like and space like intervale. Null									
	space	e-time of speci	al relativity,	Iim	e-like	, light-l	like ar	id space-like	e intervais, Null	
	cone,	Proper time, V	Vord line of	a par	ticle,	Four ve	ectors	and tensors	in Minkowskian	
	space	e-time.								20
	[Cou	rse Outcome(s	s) No.: 3 and	d 4]						
	Varia	tion of mass v	with velocity	, Equ	uivale	nce of	mass	and energy,	Transformation	
	equat	tions for mass	s, momentu	m a	nd en	ergy,	Energ	y momentu	m four vector,	20
ш	Relat	ivistic force	and Transfe	orma	tion e	equation	ns for	r its comp	onents, Energy	20
	mom	entum tensor	of a con	tinuo	us m	aterial	distri	ibution, Ele	ectromagnetism,	
	Dens	ities of electric	charge and	curr	ent, P	ropagat	tion of	electric and	l magnetic field	
	strens	oths. Transfor	mation equa	ations	s for	electro	omagn	etic four p	otential vector.	
	Trans	sformation eq	uations for	elea	etric	and m	nagneti	ic field str	engths Gauge	
	transf	formation in	tensor form		rentz	force	on a	charged r	article Energy	
	mom	entum tensor o	f an electron	nagne	etic fie	ald	on u	enarged p	article, Energy	
Toyt Booker	mom	ciltum tensor o		inagin		-1 u .				
\rightarrow S B	Rane	rii Special The	ory of Relat	ivity	рні	2010				
► K. D	Kror	i. Fundamental	s of Special	and (Genera	al Relat	ivity.	PHI Publica	tion. 2010.	
\succ J. V.	Narlil	kar, An Introdu	ctions to Rel	lativi	ty, Ca	mbridg	ge Univ	versity Press	, 2010.	
D.C. D										
Keterence B	ooks:	The Former 1	actures on I	Dh.			duast	ion India 20	12	
Feyn	inan,	The reynman I	Lectures on I	rnysi v No	cs, Pe	aisofi E 9 Intorr	ationa	oli muia, 20 d Privata I :-	12.	
\rightarrow A. E.	ohm '	The Special Th	or relativit	y, ine tivity	w Age	tledge	2006	u FIIVate LII	inteu, 2000.	
→ D. D → T M	Helli	iwell Snecial F	Cory of Kela Relativity II	niver	sitv Se	cience l	2000. Books	2009		
\succ L P	Eisen	hart. Reimanni	an Geometry	v. Pri	ncetor	1 Unive	ersity F	Press. 1997		

Course No:	: 3	Course Name: Ge	eneral Relativity and Cos	mol	ogy	Cou	rse	Code: N	IMAE 00	03		
Batch:		Programme: M.Sc.	Semester:	L	Т	Р	J	Credits	Contact I Per We	Hrs ek: 4		
2024-2026		Mathematics	III/IV	4	0	0	0	4	Total Ho	ours: 40		
Total Evalu	ation I	Marks: 100	Examination Duration: Mid Term (2 hours), End Term (3 hours)									
Theory As Internal A	sessme ssessm	ent: 75 Marks ent: 25 Marks	Pre-requisite of course	: Spo	ecial	Rela	tivi	ty				
Course	This o	course will develop	a profound understanding	of g	enera	al rel	ativi	ity, and S	Schwarzsc	hild and		
Objective	Reiss mode focus	ner-Nordström solu ls, Friedmann mod es on employability	tions.The students will els, cosmological implic and skill development alig	learn atior gned	n the ns ar with	cor d th all C	ncep neir O's	ts of st applicati	atic cosm ons. This	ological s course		
Course Outcomes	After CO1: CO2: CO3:	studying these topic Find Einstein's field Understand Schwar Determine the Einst	s, the students will be able l equations and express its zschild internal and extern tein-Maxwell equations ar	e to: s phy nal so nd the	sical olutio e Rei	signi ons. ssner	fica -No	nce. rdström	solution.			
	CO4: CO5:	CO4 : Derive modified field equations for cosmological models. CO5 : Calculate various cosmological implications and compare them with the actual univer.										
	C00.	Deal with the coshi										
Module No).		Content							Hours		
	[Cou	rse Outcome(s) No	o.:1, 2 and 3]									
	Princi	iple of equivalence	e and general covariand	ce, (Geod	esic	prir	nciple, N	Jewtonian	L		
	appro	eximation of relativi	istic equations of motion	n, Ei	nstei	n's fi	eld	equation	ns and its	20		
Ι	Newt	onian approximation	n, Schwarzschild extern	nal s	olutio	on ai	nd i	ts isotro	pic form,	20		
	Plane	tary orbits and ana	logues of Kepler's Laws	s in	gene	eral r	elat	ivity, Ac	lvance of			
	perihe	elion of a planet, I	Bending of light rays in	a g	ravit	ation	al f	ield, Gra	vitational	-		
	redsh	ift of spectral lines, I	Radar echo delay, Energy	-moi	nenti	um te	enso	r of a pei	fect fluid,			
	Schw	arzschild internal so	lution, Boundary condition	ons, 1	Energ	gy m	ome	entum ter	nsor of an			
	electr	omagnetic field, Ein	stein-Maxwell equations,	Reis	sner-	Nord	strö	m solutio	on.			
	[Cou	rse Outcome(s) No	a.: 4, 5 and 6]			1. 0.	1.0					
	Cosm	ology-physical univ	erse, Mach's principle, El	inste	n mo	odifie	d fi	eld equa	tions with			
II	doriv	ological term, Stat	nd comparison with the	10	Eins	stein	and	a Hubb	tter, then	20		
	Cosm	allon, properties a	Weyl's postulate Deriv	le a	of	Roh	orts	e, Hubi m-Walk	er metric			
	Hubb	le and Deceleration	n parameters Redshift	Red	shift	ver		distance	relation			
	Angu	lar size versus redsh	ift relation and source co	unts	in Ro	oberts	son-	Walker s	spacetime			
	Fried	mann models. Fund	amental equations of dyr	namia	cal co	osmo	logy	Critica	l density	,		
	Close	ed and open universe	es. Age of the universe. N	latte	r don	ninat	ed e	ra of the	universe.			
	Einste	ein-de Sitter model,	Particle and event horizo	ns, E	ddin	gton	Len	naitre mo	odels with	L		
	Lamb	da-term, Perfect cos	mological principle, Stead	ły sta	ite co	smol	ogy					
Text Books	:			,			20			·		
➢ K.	D. Kro	ri, Fundamentals of	Special and General Relat	ivity	, PHI	Pub	licat	ion, 201	0.			
 S. Weinberg, Gravitation and Cosmology, Principles and applications Dublishing, 2005 						ions (of G	eneral R	elativity, '	Wiley		
Pu L	Dlishing V Narl	g, 2005. ikar An Introduction	n to Relativity Cambridge	Uni	Verei	tv Pr	200	2010				
→ J. `	V. Narl	ikar, Cosmology, Ca	mbridge University Press.	, 200	3.	.y 1 10	-55,	2010.				
> I. I	B. Khrij	plovich, General Rel	ativity, Springer Science	& Bu	sines	s Me	edia,	2005.				

Reference Books:

- C. E. Weatherbum, An Introduction to Riemannian Geometry and the Tensor Calculus, Cambridge University Press, 2008.
- H. Stepheni, General Relativity: An IntMMroduction to the Theory of Gravitational Field, Cambridge University Press, 1990.
- S. Eddinglon, The Mathematical Theory of Relativity, Cambridge University Press, 1965.
- > J. V. Narlikar, General Relativity and Cosmology, Palgrave, 2013.
- R. Adler, M. Bazin & M. Schiffer, Introduction to General Relativity, McGraw Hill Inc., 1975.
- > B. Schutz, A First Course in General Relativity, Cambridge University Press, 1990.
- S. Weinberg, Gravitation and Cosmology: Principles and Applications of the General Theory of Relativity, John Wiley & Sons, Inc., 1972.
- R. K. Sachs & H. Wu., General Relativity for Mathematician, Springer Verlag, 1977.
- > J. L. Synge, Relativity: The general Theory, Elsevier Science Publishing Co., 1976.

Course No: 4	4	Course Name: Sp	ecial Functions			Сот	ırse	e Cod	le: MMAE 00	004	
Batch:		Programme:	Semester:	L	Т	Р	J	Crea	lits Contact 1	Hrs	
2024-2026		M.SC. Mathematics	II/III/IV	4	0	0	0	1	Total He	ek:4	
Z024 2020 Total Evalua	tion	Marks. 100		4	<u> </u>			4		<u>)urs: 40</u>	
		Viai KS. 100	Examination Duration: N	11d	Teri	m (2	ho	urs),	End Term (3	hours)	
Theory Asso Internal Ass	essme sessm	ent: 75 Marks ent: 25 Marks	Pre-requisite of course: Ordinary differential equation								
	This	course will develop	a profound understanding	of	hyp	er g	geor	netric	functions a	nd their	
Course	prope	erties. The students	will learn the concepts off	unc	tiona	als,	vari	ation	al problems	and the	
Objective	appli	cations of special f	unctions in solving different	ntia	l eq	uati	ons.	Thi	s course foc	uses on	
	Δfter	studying these tonic	s the students will be able to								
	CO1	: Solve, and interpret	solutions of differential equa	atio	ns u	sing	spe	cial f	unctions		
Course	CO2 : Derive the results of some classical special functions and orthogonal polynomials.										
Outcomes	CO3	CO3: Understand and use Legendre, Bessel, Elliptic and Dirac-Delta functions.									
	CO4	Use Euler's equatio	n to solve isoperimetric prob	lem	ıs.						
	CO5: Analyze and solve variational problems with moving boundaries.										
	CO6	: Apply Ritz, Galerki	n and Kantorovich methods	to s	olve	a bo	oun	lary v	alue problem	1.	
COURSE SYLLABUS											
Module No.			Content							Hours	
	[Course Outcome(s) No.: 1, 2 and 3]										
	Anal	ytical study of Bet	a and Gamma functions v	vith	co	mpl	ex	argun	nents, Hyper		
	geom	etric Functions, Ger	neralized and confluent hype	er g	geon	netri	c fu	nctio	ns, Legendre		
Ι	and	Bessel Functions wi	th Complex arguments. Ch	ieby	yshe	v, I	Lagu	lerre	and Hermite	20	
	polyn	omials, Orthogonal	sets of Function, Elliptic func	ctio	ns o	f We	eiers	strass	and Jacobian	L	
	inclu	ding Theta functions.	Jacobian polynomials, The	Dira	ac-D	elta	fun	ction.			
	[Cou	rse Outcome(s) No	.: 4, 5 and 6]								
	Calc	ulus of Variations:	Introduction, Functional and	d ez	xtrer	nal,	Inv	arian	ce of Euler's	5	
	equat	ion under coordinate	transformation, Isoperimetr	ic p	robl	ems	, Va	riatio	nal problems		
II	with	moving (or free) bou	indaries, Proper and central	fiel	ds, 1	Field	d of	extre	mals, Jacobi,	20	
	Weie	rstrass and Lagrange	's conditions, Rayleigh-Ritz	and	l Ga	lerk	in n	etho	ls for solving	20	
	boun	dary value problems	s (BVP) involving an ordin	nary	dif	fere	ntia	1 equ	ation, Euler-	-	
	Ostro	gradsky equation, F	Ritz and Kantorovich metho	ds	for	solv	ing	BVP	involving a	L	
	partia	al differential equation	n.								
Text Books:	1									1	
➤ M. A	. Path	an, P. K. Banerji, V	. B. L. Chaurasia & M. C. C	Goy	al: S	Spec	ial	Funct	ions and Cal	culus o	
Varia	tions,	Indus Valley Publica	ations, 2004.	-		-					
N. Sa	ran, S	. D. Sharma & T. N.	Trivedi, Special Functions,	Prag	gati	Prak	cash	an, 20)19.		
► A. S.	Gupta	a: Calculus of Variati	ons with Applications, PHI,	199	7.						

> M. D. Raisinghania, Advanced Differential equations, S. Chand and Co. Ltd., 2022.

Reference Books:

- E. D. Rainvelle, Special Functions, Chelsea Pub Co, 1971.
- > I. M. Gilgand & S. V. Fomin, Calculus of Variations, Dover Publications Inc., 2000.
- > E. T. Copson, An Introduction to the Theory of Functions of Complex Variables: OUP, 1970.

Course No:	5	Course Name: Partial Differential Equations-II Course Code: MMAE 0006												
Batch:		Programme:	Semester:	L	Т	Р	J	Credits	Contact	Hrs				
2024-2026		M.Sc.							Per We	ek:4				
		Mathematics	IV	4	0	0	0	4	Total H	ours: 40				
Total Evalu	ation 1	Marks: 100	Examination Duration: N	/lid	Ter	m (2	2 ho	urs), En	d Term (3	3 hours)				
Theory Ass Internal As	sessme sessm	ent: 75 Marks ent: 25 Marks	Pre-requisite of course: P	arti	al D	oiffe	rent	tial Equa	tions-I					
Course	This	course will develop	a basic understanding of	Gre	en's	fun	octic	on and it	ts propert	ties. The				
Objective	stude	nts will learn the use	e of energy methods to discu	ss tl	he u	niqu	iene	ss of sol	ution of h	eat flow				
	and v	and wave equations along with their more applications in science and engineering. This co												
	focus	bcuses on employability and skill development aligned with all CO's.												
	After	After studying these topics, the students will be able to:												
Course		CO1: Understand the concept of Green's functions.												
Outcomes		CO2 : Use Green's function to find the solutions of PDEs.												
Outcomes		-03: Find the fundamental solutions of heat and Laplace equations.												
		CO5: Solve the Wave equation and interpret the solution												
		CO6: Use the energy method to discuss the uniqueness of solution.												
		b: Use the energy me		55 0	1 50	uuo								
			COURSE STELABOS											
Module No	•		Content							Hours				
	[Cou	rse Outcome(s) No	b.: 1, 2, 3 and 4]											
	Green	n's formula, Corre	ctor function (defination of	only), (Gree	n's	function	n and it	s				
	deriv	ation, Representation	on formulausing Green's f	func	tion	, S	ymr	netry of	f Green'	s				
I	funct	ion, Energy meth	ods: Uniqueness, Dirichl	et	Pri	ncip	le,	Heat 1	Equations	: 20				
	Fund	amental solution of h	eat equation, Uniqueness of	hea	t equ	uatic	on: I	Energy m	nethods.					
	[Con	urse Outcome(s) No	1		1			0.						
	Wave	equation-Physical	interpretation Solution for	one	. dii	nen	sion	al wave	equation					
	Doflo	equation Thysical	vation of Euler Poisson Da	rha		20110	tion	kirchl	off's and	, 1				
II	Doigo	on's formulas (for n	-2 2 only) Solution of non	100 . ho	ux (equa			unition fo	20				
	POISS	on's formulae (for h	-2, 3 only), Solution of non	1-110	mog	gene	ous	wave eq	uation to	ſ				
	n=1,	3. Energy method: U	niqueness of solution.											
Text Books:	- -					1			2015					
L.C.	Evans	s, Partial Differential	Equations: Graduate Studies	s in	Mat	hem	atic	s, AMS, 200c	2015.					
\succ I. N.	Snedd	ien, Elements of Part	al Differential Equation, Do	ver	Pub	licat	lon	5,2000.	actions ?	011				
P.V	. O Ne E Wai	nharger A First Co	urse in Partial Differential	Lea	ariii noti	ig C	usic		ox Voria	UII. bles and				
Tran	sform	Methods, John Wiley	y & Sons, 2012.	Ľq	uati	011.	witi	r compi		bles all				
Reference	Books	•												
→ M.E	D. Raisi	inghania, Advanced	Differential Equation, S. Cha	nd	and	Con	npai	ny Ltd., 2	2018.					

S. L. Ross, Differential Equations, Wiley, 2007.

Course No:	6	Course Nam	e: Fluid Dyn	amic	s-I	Cours	se Cod	e: MMAE	0007				
Batch:		Programme: M.Sc.	Semester:	L	Т	Р	J	Credits	Contact Hrs Per Week:4				
2024-2026		Mathematics	III/IV	4	0	0	0	4	Total Hours: 4	0			
Total Evalu	ation	Marks: 100	Examinatio	on Di	iratio	n: Mid	Term	(2 hours), I	End Term (3 hour	rs)			
Theory Ass Internal As	sessme ssessm	ent: 75 Marks ent: 25 Marks	Pre-requisi	te of	cours	se: Con	nplex A	Analysis, Te	ensor Analysis				
Course	This	course will dev	elop a profo	und ı	unders	tanding	of flu	id flow beh	aviors. The stude	ents will			
Objective	learn	the concept of	various fluid	moti	ons an	d stream	n funct	tion. Further	, a deep understa	nding of			
	two a	and three dimen	nsional inviso	cid fl	uid flo	ows wil	l be d	eveloped in	this course. This	s course			
	focus	es on employab	ility and skill	l deve	elopme	ent aligr	ned wit	h all CO's.					
	After studying these topics, the students will be able to:												
G	CO1	Derive the path	n lines and th	e stre	amlin	es in ca	rtesian	and polar fo	orms of a velocity	field.			
Course	CO2	O2 : Find the stream function from a velocity field.											
Outcomes	CO3	CO3: Learn Euler's and Bernoulli's equations of motion of fluid.											
	CO4	CO4: Understand inviscid fluid flow and use the continuity equation to determine whether an											
		inviscid flow is	incompressi	ble.									
			COU	JRSI	E SYL	LABU	S						
Module No	•				Cont	ent				Hours			
	[Course Outcome(s) No.: 1 and 2]												
	Kine	matics of Fluid	ls in Motion	Rea	al fluic	ds and i	deal fl	uids, Veloc	ity of a fluid at a				
_	point	, Stream lines a	nd path lines	, Mat	hemat	tical for	ms in v	various fluic	l motions (steady	20			
I	and unsteady, compressible and incompressible, rotational and irrotational etc.), The												
	velocity potential, The velocity vector, Local and particle rates of change, Equation of												
	continuity, Acceleration of fluid.												
	[Cou	rse Outcome(s	s) No.: 3 and	1 4]									
	Equa	tions of Motion	n of fluid: Eu	ıler's	equati	ions of 1	motion	, Bernoulli'	s equation.				
	Two	and Three D	imensional	Invis	cid F	luid Fl	ows:	Complex po	otential, Sources,	20			
11	Sinks	, Doublets, In	ages with 1	respec	et to	plane a	and cir	rcle, Milne	Thomson circle	20			
	theor	em, Blasius the	orem, Motio	n pas	t a cii	rcular c	ylindeı	, Axisymm	etric flows, Non-				
	dime	nsionalized par	ameter, Sto	kes's	strea	m fund	ction,	Motion pa	st a sphere, D-				
	Alem	bert's paradox.											
Text Books	:												
\succ F. Chor	lton, T	extbook of Fluid	d Dynamics,	CBS	Publis	hers &	Distrib	utors, 2004.	2012				
🎽 G. K. B	atchelo	or, An Introduct	ion to Fluid I	Jynar	nics, (ambric	ige Un	iversity Pres	s, 2012.				
Reference I	Books:												

- M. D. Raisinghania, Fluid Dynamics, S. Chand and Company Ltd., 2003.
 D. E. Rutherford, Fluid Dynamics, Oliver and Boyd Ltd, 1978.

Course No: '	7	Course Name	e: Fluid Dyr	namic	s-II	Course Code: MMAE 0008							
Batch:		Programme: M.Sc.	Semester:	L	Т	Р	J	Credits	Contact Hrs Per Week:4				
2024-2026		Mathematics	IV	4	0	0	0	4	Total Hours: 4	0			
Total Evalua	ation I	Marks: 100	Examinatio	on Di	uratio	n: Mid	Term	(2 hours), l	End Term (3 hour	rs)			
Theory Asso Internal Ass	essme sessm	nt: 75 Marks ent: 25 Marks	Pre-requisi	ite of	cours	e: Fluid	d Dyna	mics - I					
Course Objective	This of Furth cours	course will deve er, a deep under e. This course fo	elop a profou standing of l ocuses on em	ind un oound oploya	ndersta lary la ability	unding of yer theo and ski	of flow ory and 11 deve	of fluid and nano-fluid lopment ali	d Navier-Stoke ec s will be develope gned with all CO'	uations. d in this s.			
Course Outcomes	 After studying these topics, the students will be able to: CO1: Derive some exact solutions of Navier-Stokes equations. CO2: Analyze properties of various fluid flows. CO3: Understand the boundary layer, momentum and energy integral equations and find their separations. CO4:Learn the nano-fluids and their applications. 												
	1		CO	URSI			S						
Module No.					Cont	ent				Hours			
I	[Cou Navie chang due t flow, proble	rse Outcome (s er-Stokes Equa ge of circulation o viscosity, Exa Hagen-Poiesuil em.) No.: 1 and tions and it , Diffusion of act solutions le flow thro	2] s Exa of voi of N ugh a	act Sol rticity, lavier- a pipe,	utions: Vortic: Stokes Flow t	Navi ity equ equation hrough	er-Stoke's e ation and E ons: Couette a annular re	equations, Rate of energy dissipation e flow, Poiseuille gion, Stokes first	20			
П	[Course Outcome(s) No.: 3 and 4] Boundary Layer Theory: Laminar boundary layer, Two-dimensional boundary layer equations, Blasius equation, Boundary layer parameters, Separation of boundary layer, momentum and energy integral equation. Nano Fluids: Introduction to nano fluids. Some applications of nano fluids									20			
Text Books: ≻ F. Ch ≻ M. D	orlton . Raisi	, Textbook of Finghania, Fluid I	luid Dynami Dynamics, S	cs, Cl . Cha	BS Pul nd and	blishers Compa	& Dis any Lto	tributors, 20 1., 2003.	004.				
Reference B ≻ G. K.	ooks: Batcł	nelor, An Introdu	uction to Flu	id Dy	mamic	s, Caml	oridge	University I	Press, 2012.				

- D. E. Rutherford: Fluid Dynamics, Oliver and Boyd Ltd., 1978.
 H. Schlichting, Boundary Layer theory, Mc Graw Hill, 2014.
- > S. K. Das, S. U. S. Choi, W. Yu & T. Pradeep, Nano Fluid Science and Technology, Wiley-Interscience, 2008.
| Course No: | 8 | Course Name | : Discrete M | athemat | ics | Cours | se Co | ode: MMAE | E 1009 | |
|--------------------|-----------------|---------------------------------|---------------------------------|----------------------------|------------|----------------|---------------|----------------|---|----------|
| Batch: | | Programme:
M.Sc. | Semester: | L | T | Р | J | Credits | Contact Hrs
Per Week:4 | |
| 2024-2026 | | Mathematics | II/III/IV | 4 | 0 | 0 | 0 | 4 | Total Hours: 4 | 0 |
| Total Evalua | ation N | farks: 100 | Examinatio | on Dura | tion: | Mid 7 | [
[
erm | (2 hours), I | End Term (3 hou | rs) |
| | | 4 75 M. 1 | | | | | | | × | , |
| Internal Ass | sessme | nt : 75 Marks | Pre-requisi | te of cou | arse: | Algeb | ra | | | |
| Course | This c | course will dev | velop a profo | und und | ersta | nding | of pa | rtially order | ed sets, lattices, | Boolean |
| Objective | algebr | a and their ap | plications. F | urther, a | dee | o unde | rstan | ding of spe | ctra of finite gra | phs and |
| | regula | r graphs, Cayl | ley graphs a | nd Rama | nujaı | ı grapl | hs w | ill be devel | oped in this cour | se. This |
| | course | e focuses on en | ployability a | nd skill o | level | opmen | t alig | ned with all | CO's. | |
| | After | studying these | topics, the stu | idents wi | ill be | able to |): | 11 | | |
| Course | COI: | Understand pa | rtially ordere | d sets, la | ttices | , their | types | s and lattice | homomorphism. | rom of |
| Outcomes | CO2: | modular lattice | ve milervais, | Schreier | s Rei | meme | | eorem and I | somorphism meo | |
| | CO3 : | Apply the De I | .s.
Morgan Form | ulae wit | h exa | mples. | | | | |
| | CO4 : | Use the concep | ots of Boolea | n algebra | and | truth ta | able. | | | |
| | CO5 : | Understand the | e concepts of | spectra o | of gra | phs an | d app | olication of s | pectra. | |
| | CO6 : | Calculate the en | nergies of dif | ferent typ | pes o | f graph | ıs. | | | |
| | 1 | | CO | URSESY | YLL | ABUS | | | | |
| Module No. | | | | Co | onter | ıt | | | | Hours |
| | [Cour
Lattic | rse Outcome (
ce Theory: Par | (s) No.: 1, 2
tially ordered | and 3]
d sets, D | iagra | ms, Lo | ower | and Upper | Bounds, Lattices, | |
| | The la | ttices theoretic | al duality pri | nciple, S | emi | attices | , Lat | tices as parti | ally ordered sets, | |
| Ι | Diagra | ams of lattices | , Sub lattices | s, Lattice | hon | nomorp | ohism | n, Axiom sy | stems of lattices, | |
| | Comp | lete lattices, D | Distributive la | attices, N | lodu | lar latt | ices, | Characteriz | ation of modular | 20 |
| | and d | istributive latt | ices, Similar | interval | ls, Pi | ojectiv | ve in | tervals, Zes | senhau's lemma, | 20 |
| | Schrei | ier's refinemen | nt theorem, | Independ | lent | sets w | rith p | properties, 7 | The isomorphism | |
| | theore | m of modular l | lattices. | | | | | | | |
| | Boole | an Algebra l | I: De Morg | an form | ulae, | Com | olete | Boolean a | lgebras, Boolean | |
| | algebr | as and Boole | ean rings, T | The alge | bra | of rel | ation | s, Boolean | homomorphism, | |
| | Repre | sentation theor | em. | | | | | | | |
| | [Cou | rse Outcome(s | s) No.: 4, 5 a | nd 6] | | | | | | |
| | Boole | an Algebra II: | : Boolean ex | pression, | Algo | orithm | for f | inding sum- | of-products form, | |
| | Minin | nal sum-of-pro | ducts, Conser | nsus of fu | ındar | nental | prod | ucts, Algorit | hm, Logic, Gates | |
| 11 | and C | ircuits, Boolean | n functions a | nd its trut | th tab | le. | | | | 20 |
| | Specti | a of finite grag | phs, Characte | eristic po | lynoi | nials, | Speci | tra, Spectra | of K _n , C _n and P _n , | 20 |
| | Bound | ls of spectra, T | The spectra of | regular | grapł | ns, The | e spec | ctrum of the | complement of a | |
| | regula | r graph, Spect | tra of line gi | aphs of | regu | lar, Sp | ectru | im of the co | omplete Bipartite | |
| | graph | K _{p;q} , Cayley | graphs, Unit | ary Cayl | ey gr | aphs s | pecti | rum of the (| Cayley graph Xn, | |
| | Strong | gly regular grap | ohs, Ramanu | jan graph | ns, Er | nergy c | of a g | raph, Maxir | num energy of k- | |
| | regula | r graphs, Energ | gy of Cayley | graphs. | | | | | | |
| Text Book: | 1 | | | | | | | | | |
| ➤ N. | Jacob | son: Lectures in | n Abstract Al | gebra, Ba | asic (| Concep | ots, Sj | pringer-Verl | ag, 2012. | |
| - | | | | | | | | | | |
| Keference B | ook: | Internal | | | | • D | . 104 | 2 | | |
| 🎽 U. | SZASZ. | , miroauction to | o Laurce The | ory, Aca | uemi | <u>c</u> rress | 5, 190 | | | |

Course No:	9	Course Nam	e: Integral E	quation		Cou	rse	Code: MM	AE 0010	
Batch:		Programme: M.Sc.	Semester:	L	Т	P	J	Credits	Contact Hrs Per Week:4	
2024-2026		Mathematics	II/III/IV	4	0	0	0	4	Total Hours: 4	0
Total Evalu	ation 1	Marks: 100	Examinatio	on Dura	tion: N	fid To	erm	(2 hours), I	End Term (3 hou	rs)
Theory Ass Internal As	sessme ssessm	ent: 75 Marks ent: 25 Marks	Pre-requisi transform	ite of cou	urse: C	Ordina	ry D	Differential H	Equations, Laplace	e
Course	This	course will dev	elop a profoi	und unde	rstandi	ng of	inte	gral equation	ns and their appl	ications.
Objective	The r	nain objective o	of the course	is to mal	ke the l	earne	r fan	niliarize wit	h the types of ker	nel, and
	the s	olution of integ	gral equation	s using v	various	meth	ods.	Further, th	e students will l	earn the
	meth	ods to find th	e solution of	of integra	al and	integ	gro-c	lifferential	equations using	Laplace
	transf	form. This cour	se focuses or	n employ	ability	and sl	cill c	levelopment	aligned with all	CO's.
	After	studying these	topics, the stu	udents w	ill be al	ole to:				
Course	CO1	: Understand the	e classificatio	n integra	al equat	ions.				
Course	CO2	Convert initial	and boundar	y value p	oroblem	is to a	n in	tegral equation	on.	
Outcomes	CO3	: Use the conce	pt of differen	nt kernel	s and te	echnic	ques	for solving	various kinds of	integral
		equation.								
	CO4	: Apply integral	transforms to	o find the	e soluti	on of	integ	gral equation	ns and integro dif	ferentia
		equations.								
	CO5	: Construct Gree	en's function	and know	w its ap	plicat	ions			
			COU	JRSE SY	YLLA	BUS				
Module No	•			Co	ontent					Hours
	[Cou	rse Outcome(s) No.: 1, 2 a	and 3]						
	Linea	ır Integral equ	ations, some	e basic	identiti	ies, I	Defir	nition and	Classification of	
	Fredh	nolm and Volte	rra integral e	equations	s with o	differe	ent t	types of ker	nels (Symmetric,	
Ι	Separ	able, Iterated, I	Resolvent etc	.), Convo	ersion o	of init	ial a	and boundar	y value problems	20
	to an	integral equation	on. Homoger	neous Fre	edholm	integ	ral e	equation of	second kind with	
	separ	able kernel. Eig	en values and	d Eigen f	unction	IS.		1		
		rea Outcoma	$\frac{1}{2} N_0 \cdot 4 on$	1 5 1	anotion					
			s_{1} v_{2} a_{1}	1 5] 14 - 14 - 14 - 14			:			
	Solut	ion of Fredric	and vo	onterra 1	ntegrai	equa	ation	is using R	esoivent kernei,	
п	Succe	essive approxim	ation and Ne	umann se	eries m	ethod	•			20
	Lapla	ice transform for	or solving int	egral equ	uations:	Solu	tion	of Abel's e	equation, Volterra	
	integ	ral equations v	vith convolu	tion type	e kerne	els ar	nd in	ntegro-diffe	rential equations.	
	Green	n's function and	l its propertie	es, Reduc	ction of	f bour	ndary	y value proł	olem to Fredholm	L
	integ	ral equation wi	th kernel as	Green f	unction	, Gre	en's	Function f	or Homogeneous	
	condi	tions.								
Text Books										
\rightarrow R.P.	Kanw	al. Linear Integ	ral Equation.	Theory a	and Tec	chniai	ies.	Academic P	ress. 2014.	
> A. Je	erri. Int	roduction to Int	egral Equation	ons with	Applica	ations	. Joł	nn Wilev &	Sons, 1999.	
> M. D). Raisi	inghania, Integr	al Equations	and Bou	ndary V	/alue	Prot	olems, S. Ch	and and Co. Ltd.,	2016.
> A. I	B. Cha	indramouli, Int	egral Equation	ons with	n Boun	dary	Val	ue Problem	s, Shree Siksha	Sahitya
Prak	cashan, Meerut, 2020									
Reference	Rooka	•								
	DUUKS 1 Waz	Waz A First Co	urse in Inter	ral Equat	ione W	Iorld	Scia	ntific Dublic	hing Co. 2015	
	1. Waz Jumar	waz, A Filst CO	Differential	Equation	ns and		nlue	of Variatio	nng CU., 2013.	iere and
Dist	ributor	s Pvt. Ltd., 2013	3.	Lyuanoi	iis anu	Care	u1U3			iers all

Course No:	10	Course Nam	e: Optimizat	ion Tech	nniques	Cou	rse	Code: MM	AE 0011	
Batch:		Programme: M.Sc.	Semester:	L	Т	Р	J	Credits	Contact Hrs Per Week:4	
2024-2026		Mathematics	III/IV	4	0	0	0	4	Total Hours: 4)
Total Evalua	ation I	Marks: 100	Examinatio	on Dura	tion: M	lid Te	erm	(2 hours), H	End Term (3 hour	rs)
Theory Ass Internal As	essme sessm	nt: 75 Marks ent: 25 Marks	Pre-requisi	te of cou	irse: N	il				
Course	This o	course will deve	elop a profou	nd under	standin	g of a	optin	nization. op	timization algorit	hms and
Objective	their	applications in l	Engineering.	This cou	rse incl	udes	vario	ous methods	s to solve constrai	ned and
Objective	uncor	strained optim	ization prob	lems Fu	rther a	dee	n iir	nderstanding	of modern met	hods of
	optim	ization will be	developed in	n this co	urse T	his c	ours	e focuses o	n employability a	nd skill
	devel	opment aligned	with all CO'	s	uibe. 1		ours		ii employuomity t	und Skin
	After	studying these	topics the st	<u>.</u> idents wi	ill be ab	le to:				
	COI	Know the basic	c concepts of	ontimiz	ation of	ntima	lity	criteria and	applications	
Course	CO2	Understand the	e concepts of	king of di	ifferent	optir	nizat	tion techniq	les	
Outcomes	CO3	Learn the conc	ents of vario	us optimi	zation a	algori	thm	s to find the	solution of const	rained
	000	and unconstrain	ed optimizat	ion prob	lems					unica
	CO4:	Know various	modern meth	ods of o	ntimizat	tion.				
	100		COU	JRSE SY	YLLAI	BUS				
Module No.	•			Co	ontent					Hours
	[Cou	rse Outcome(s)	No.: 1 and 2	2]						
	Introc	luction to Optin	nization, Eng	ineering	applica	tion c	of Op	ptimization,	Optimal problem	
	form	ulation, Classific	cation of opti	mization	proble	m, Co	onve	ex sets, Conv	vex functions and	
I	their	properties, Opt	timum design	n concep	ots: Def	initic	on o	f Global ar	nd Local optima,	20
	Optin	nality criteria, F	Review of bas	sic calcul	lus cond	cepts.	Glo	bal optimal	ity, Optimization	
	algori	ithms for solvi	ng unconstra	ined opti	imizatio	n pr	oble	ms. Gradiei	nt based method:	
	Cauc	hv's steenest de	scent method	Newtor	n's meth	nod (oni	ugate gradie	ent method	
	[Cauch			1, 110 w to1	i s meu	iou, c	Jong	ugate gradie	int method.	
		rse Outcome(s	s) No.: 3 and	14]						
	Optin	nization algorith	ims for solvi	ng constr	ained o	ptimi	zatio	on problems	, Direct methods,	
п	Penal	ty function m	ethods, Stee	epest des	scent n	netho	d, I	Engineering	applications of	20
ш	const	rained and unco	nstrained alg	orithms.	-1:41		c :	1-41	-1: A 4 1	20
	wode	ern methods of (optimization:	Genetic	algorit	nms,	51m	ulated anne	anng, Ant colony	
	optim	nization, Tabu s	search, Neura	al-Netwo	rk base	ed op	timi	zation, Use	of MATLAB to	
	solve	optimization pr	oblems.							
Text Books:										
➤ S. S.	Rao, F	Engineering Opt	imization, Th	neory and	l Practio	ce, No	ew A	Age Internat	ional Publishers, 2	2012.
► K. De	eb, Op	timization for E	Ingineering D	Design Al	gorithm	ns and	l Ex	amples, PH	l, 2000.	
➢ C. M	ohan &	& K. Deep, Opti	mization Tec	chniques,	New A	.ge In	dia 1	Pvt. Ltd, 20	09.	
Reference B	ooks:									
► K. V.	. Mitta	I & C. Mohan,	Optimization	Methods	s in Sys	tem A	Analy	ysis and Op	erations Research	, New
Age	India F	vt. Ltd, 2016.		-		_	_			
\rightarrow A. Ra	avindra	an, D. T. Phillip	s & J. J. Solt	berg, Ope	erations	Rese	arch	: Principles	and Practice, John	n wiley
and S	Sons, 1	987.			F		. .	D 1		
▶ J. C.	Pant, I	introduction to (Jptimization	Operatio	ons Rese	earch	, Jan	n Brothers, 2	2008.	

Course No:	11	Course Name	: Non-Linea	r Pro	gramming	Cours	se C	ode: MM	AE 0012	
Batch:		Programme: M.Sc.	Semester:	L	Т	Р	J	Credits	Contact Hrs Per Week:4	
2024-2026		Mathematics	IV	4	0	0	0	4	Total Hours: 40)
Total Evalua	tion N	Marks: 100	Examinatio	on Du	uration: Mi	d Tern	n (2	hours), E	nd Term (3 hour	rs)
Theory Asse Internal Ass	essme sessme	nt: 75 Marks ent: 25 Marks	Pre-requisi	te of	course: Op	eration	al R	lesearch		
Course Objective	This gener progra develo with a	course will de alizations, optin amming, and oped in this co all CO's	velop a prom nality, duality optimality a urse. This co	found y and and course	l understand related resu luality for focuses on	ling of lts. Fur nonline employ	con ther ear abil	vex and , a deep u program lity and sl	concave function nderstanding ofn ning problems kill development	ns, their onlinear will be aligned
Course Outcomes	After CO1: CO2: CO3: CO4:	studying these to Understand the Apply the optin Understand the Learn optimali	topics, the stu e concept of c mality and du e nonlinear pu ty theorems f COU	udent conve iality rograt for no	s will be able ex and conca for generalized mming prob onlinear prog E SYLLAB	e to: ve func zed cor lems ar grammi US	ction ivex id fi ng p	ns and thei and conc nd their o problems a	r generalizations ave functions. ptimality and dua and their application	llity. ions.
Module No.					Content					Hours
Ι	[Cou Pseud functi functi Suffic Gener neces	rse Outcome(s o convex and on and quasi c on, Optimality cient optimality calized Fritz- Jo sary optimality	s) No.: 1, 2 a pseudo con- onvex function and Dualion theorem, Geno conditions u	and 3 cave ion, I ity fo eneral ry po inder] function, R Differential or generaliz ized Kuhn-7 int necessar the week con	elation convex ced con Fucker Ty optin nstraint	ship fur nvez suff mali t qua	between totion and and contropt toticient opt ty theorem alification	pseudo convex l Pseudo convex oncave function, imality theorem, m, Kuhn-Tucker s.	20
п	[Course Outcome(s) No.: 2, 3 and 4] Optimality and duality in the presence of nonlinear equality constraints, Sufficient optimality criteria, Minimum principal, Necessary optimality criteria, Xo not open. Minimum principal, Necessary optimality theorem. Fritz- John and Kuhn-Tucker stationary point necessary optimality criteria Xo open, duality with nonlinear equality constraints.								20	
Text Book: ≻ M. S.	Bazar	aa & C. M. She	tty, Nonlinea	ar Pro	gramming, 7	Theory	and	Algorith	ns, Wiley, 2005.	L
Reference Bo ≻ M. Av	ook: vrieal,	Nonlinear Prog	ramming: A	nalys	is and Metho	od, Dov	ver F	Publication	ns, 2014.	

Course No:	12 C	ourse Name	: Operator T	Theory	y	Cours	se Cod	e: MMAE (0013	
Batch:	P	rogramme: M.Sc.	Semester:	L	Т	Р	J	Credits	Contact Hrs Per Week:4	
2024-2026	Ν	Mathematics	III/IV	4	0	0	0	4	Total Hours: 4	0
Total Evalua	ation Ma	arks: 100	Examinatio	on Du	iratio	n: Mid	Term	(2 hours), H	End Term (3 hour	rs)
Theory Ass Internal As	essment sessmen	:: 75 Marks t: 25 Marks	Pre-requisi	ite of	cours	se: Fund	ctional	Analysis		
Course	This co	urse will dev	elop a profe	ound	unders	tanding	of du	al spaces, r	eflexive spaces a	nd their
Objective	applicat	tions. The stu	dents will le	earn tl	he con	cepts o	of vario	ous operator	s defined on Ban	ach and
	Hilbert	spaces. Furth	er, a deep un	dersta	nding	of spec	tral the	eory of oper	ators will be deve	loped in
	this cou	rse. This cour	rse focuses of	n emp	oloyab	ility and	d skill (developmen	t aligned with all	CO's.
	After st	udying these	topics, the st	udent	s will l	be able	to:			
Course	CO1: U	Inderstand the	e concept of o	dual s	pace a	nd dete	rmine	it for variou	s spaces	
Outcomes	CO2: L	earn reflexivi	ty and find a	pprox	imatio	ons in th	nese sp	aces.	<i>.</i> •	
Outcomes	CO3: L	earn various (Inderstand the	operators on	Bana ults fo	ch and	Hilber	t space	s and their p	oroperties	
	04.0					I ARI	S S		en spaces.	
	1		cou		SIL		6			
Module No.	•				Cont	ent				Hours
	[Course	e Outcome(s)	No.: 1, 2 an	nd 3]						
	Dual s _l	pace, Represe	entation of	duals	of th	ie spac	es $c_0 v$	with p-norm	is, c_0 and c with	
T	suprem	um-norm, l_p ,	C[a,b] and I	L_p, Re	eflexiv	vity, We	eak an	d weak* co	nvergences, Best	20
1	approxi	mation in ref	lexive space	s, Op	erator	s on Ba	anach a	and Hilbert	spaces, Compact	20
	operator	rs and its prop	perties, Integr	ral op	erators	s as con	npact o	perators.		
	[Cours	e Outcome(s	s) No.: 3 and	d 4]						
	Adjoint	of operator	rs between	Hilbe	ert sp	aces, S	Self-ad	joint, Norn	nal and Unitary	
п	operator	rs, Numerical	range and	nume	rical r	adius, 1	Hilbert	-Schmidt og	perators, Spectral	20
11	results	for Banach a	and Hilbert s	space	opera	tors, Ei	igen sp	bectrum, Ap	proximate Eigen	20
	spectrui	m, Spectrum	and resolven	it, Spe	ectral 1	radius f	formula	a, Spectral n	napping theorem,	
	Riesz-S	chauder theor	ry, Spectral r	esults	for no	ormal, s	elf-adj	oint and uni	tary operators.	
Text Books:	Noin Enn	ational Anal	voia A Einst (C	o Duo	nting IL	11 of L	dia 2014		
\sim M. I. I	inair, Fur	Eurotional Analy	SIS: A FIFSU		e, Prei	nuce Ha	111 OI 11 (D) I 4-1	2009		
► B. V. I	Limaye, I	Functional Ar	ialysis, new	Age	Interna	itional (P) Lta	., 2008.		
Reference B	ooks:									
≻ E. Kre	yszig, In	troduction to	Functional A	nalys	is witł	n Applie	cations	, Wiley, 198	39.	
> Bollob	as, Linea	ar Analysis, C	ambridge Ur	nivers	ity Pre	ess, 199	9.	-		

A. H. Siddiqi, K. Ahmad & P. Manchanda, Introduction to Functional Analysis with Applications, Anamaya Publishers, 2006.

Batch: Programme: Semester: L T P J Credits Contact Hrs 2024-2026 Mathematics III/IV 4 0 0 0 4 Total Hours: 40 Total Evaluation Marks: 100 Examination Duration: Mid Term (2 hours), End Term (3 hours) Theory Assessment: 75 Marks Internal Assessment: 25 Marks Pre-requisite of course: Functional Analysis Course This course will develop a profound understanding ofbasics of measurable sets, Lebesgue Objective This course will develop a profound understanding ofbasics of measurable sets, Lebesgue Course This course of point wis convergence theorem and related theorems. Further, a deep understanding of Lebesgue integration and its applications will be developed in this course. This course focuse on employability and skill development aligned with all CO's. After studying these topics, the students will be able to: CO2: Understand the concepts of measurable sets and measurable functions. Outcomes CO4: Learn the construction of the Lebesgue integral and its applications. CO4: Learn the construction of the Lebesgue integral and its applications. Module No. Content Hours [Course Outcome (s) No.: 1 and 2] Review of Riemann-Stieltie's integral, Algebras of sets, Borel subsets	Batch:				ind integration	Co	urse	e Code: M	/IMAE 0014	
2024-2026 Mathematics III/IV 4 0 0 0 4 Total Hours: 40 Total Evaluation Marks: 100 Examination Duration: Mid Term (2 hours), End Term (3 hours) Theory Assessment: 75 Marks Pre-requisite of course: Functional Analysis Course This course will develop a profound understanding ofbasics of measurable sets, Lebesgu Objective measure and measurable functions. The students will learn the concepts of point wis convergence, convergence theorem and related theorems. Further, a deep understanding of Lebesgue integration and its applications will be developed in this course. This course focuse on employability and skill development aligned with all CO's. After studying these topics, the students will be able to: CO2: Understand the concept of outer measurable sets and measurable functions. Course CO1: Use the concept of outer measurable sets and measurable functions. CO2: Understand the concepts of measurable sets and measurable functions. CO2: Understand the concepts of measurable sets and measurable functions. CO4: Learn the construction of the Lebesgue integral and its applications. Module No. Content Hourse Image: Course of Riemann-Stieltie's integral, Algebras of sets, Borel subsets of R-Lebesgue	2024 2026	Programme: M.Sc.	Semester:	L	Т	Р	J	Credits	Contact Hrs Per Week:4	
Total Evaluation Marks: 100 Examination Duration: Mid Term (2 hours), End Term (3 hours) Theory Assessment: 75 Marks Pre-requisite of course: Functional Analysis Course This course will develop a profound understanding ofbasics of measurable sets, Lebesgu measure and measurable functions. The students will learn the concepts of point wis convergence, convergence theorem and related theorems. Further, a deep understanding of Lebesgue integration and its applications will be developed in this course. This course focuse on employability and skill development aligned with all CO's. After studying these topics, the students will be able to: CO1: Use the concept of outer measurable sets and measurable functions. Course CO2: Understand the concepts of measurable sets and measurable functions. Course CO2: Understand the concepts of measurable sets and measurable functions. CO2: Understand the concepts of the Lebesgue integral and its applications. CO2: CO4: Learn the construction of the Lebesgue integral and its applications. CO4: Learn the construction of the Lebesgue integral and its applications. CO4: Learn the construction of the Lebesgue integral and its applications. Module No. Content Hours [Course Outcome (s) No.: 1 and 2] Review of Riemann-Stieltie's integral, Algebras of sets, Borel subsets of R-Lebesgue	2024-2020	Mathematics	III/IV	4	0	0	0	4	Total Hours: 4	0
Theory Assessment: 75 Marks Pre-requisite of course: Functional Analysis Course This course will develop a profound understanding ofbasics of measurable sets, Lebesgue measure and measurable functions. The students will learn the concepts of point wise convergence, convergence theorem and related theorems. Further, a deep understanding of the developed in this course. This course focuse on employability and skill development aligned with all CO's. After studying these topics, the students will be able to: CO1: Use the concept of outer measure and related results. Course CO2: Understand the concepts of measurable sets and measurable functions. Outcomes CO4: Learn the construction of the Lebesgue integral and its applications. COURSE SYLLABUS Course outcome (s) No.: 1 and 2] Review of Riemann-Stieltje's integral, Algebras of sets, Borel subsets of R-Lebesgue	Total Evaluati	on Marks: 100	Examinatio	on Di	uration: Mid T	ern'	n (2	hours), E	nd Term (3 hour	rs)
Course This course will develop a profound understanding ofbasics of measurable sets, Lebesgu Objective This course will develop a profound understanding ofbasics of measurable sets, Lebesgu Module No. Course outcome (s) No.: 1 and 2] Review of Riemann-Stieltje's integral, Algebras of sets, Borel subsets of R-Lebesgue	Theory Assess Internal Asses	sment: 75 Marks sment: 25 Marks	Pre-requisi	te of	course: Functi	ona	l Ar	nalysis		
Objective measure and measurable functions. The students will learn the concepts of point wis convergence, convergence theorem and related theorems. Further, a deep understanding of Lebesgue integration and its applications will be developed in this course. This course focuse on employability and skill development aligned with all CO's. After studying these topics, the students will be able to: CO1: Use the concept of outer measure and related results. Course CO2: Understand the concepts of measurable sets and measurable functions. Outcomes CO3: Check point wise convergence and understand related results. COURSE SYLLABUS Course Module No. Content Hourse Image: Course of Relemann-Stieltje's integral, Algebras of sets, Borel subsets of R-Lebesgue Provide the subsets of R-Lebesgue	Course T	his course will de	velop a prot	found	understanding	g of	basi	cs of me	asurable sets, L	ebesgue
convergence, convergence theorem and related theorems. Further, a deep understanding of Lebesgue integration and its applications will be developed in this course. This course focuse on employability and skill development aligned with all CO's. After studying these topics, the students will be able to: Course Outcomes Course Outcomes Course Outcomes Course <	Objective m	easure and measu	rable functi	ons.	The students	wil	l le	arn the	concepts of poi	nt wise
Lebesgue integration and its applications will be developed in this course. This course focuse on employability and skill development aligned with all CO's. After studying these topics, the students will be able to: Course Outcomes Outcomes CO2: Understand the concepts of measurable sets and measurable functions. CO3: Check point wise convergence and understand related results. CO4: Learn the construction of the Lebesgue integral and its applications. COURSE SYLLABUS Module No. Course Outcome (s) No.: 1 and 2] Review of Riemann-Stieltje's integral, Algebras of sets, Borel subsets of R-Lebesgue	c	onvergence, conver	gence theore	em a	nd related theo	oren	ns.	Further, a	deep understar	nding of
on employability and skill development aligned with all CO's. After studying these topics, the students will be able to: Course CO1: Use the concept of outer measure and related results. Outcomes CO2: Understand the concepts of measurable sets and measurable functions. CO3: Check point wise convergence and understand related results. CO4: Learn the construction of the Lebesgue integral and its applications. COURSE SYLLABUS Module No. Content [Course Outcome (s) No.: 1 and 2] Review of Riemann-Stieltje's integral, Algebras of sets, Borel subsets of R-Lebesgue	L	ebesgue integration	and its appl	icatio	ons will be deve	elop	ed i	in this cou	arse. This course	focuses
Course After studying these topics, the students will be able to: Course CO1: Use the concept of outer measure and related results. CO2: Understand the concepts of measurable sets and measurable functions. CO3: Check point wise convergence and understand related results. CO4: Learn the construction of the Lebesgue integral and its applications. COURSE SYLLABUS Module No. Course Outcome (s) No.: 1 and 2] Review of Riemann-Stieltje's integral, Algebras of sets, Borel subsets of R-Lebesgue	01	n employability and	skill develop	omen	t aligned with a	ll C	O's.			
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CO3: Check point wise convergence and understand related results. CO4: Learn the construction of the Lebesgue integral and its applications. COURSE SYLLABUS Module No. Content [Course Outcome (s) No.: 1 and 2] Review of Riemann-Stieltje's integral, Algebras of sets, Borel subsets of R-Lebesgue	Outcomes C	O2: Understand the	e concepts of	meas	surable sets and	mea	asur	able funct	ions.	
CO4: Learn the construction of the Lebesgue Integral and its applications. COURSE SYLLABUS Module No. Content Hours [Course Outcome (s) No.: 1 and 2] Review of Riemann-Stieltje's integral, Algebras of sets, Borel subsets of R-Lebesgue	Outcomes (O3: Check point w	ise converger		a understand re	elate	ea re	esults.		
Module No. Content Hour [Course Outcome (s) No.: 1 and 2] Review of Riemann-Stieltje's integral, Algebras of sets, Borel subsets of R-Lebesgue		04: Learn the cons	truction of th		Sesgue integral	and	its a	application	18.	
Module No. Content Hours [Course Outcome (s) No.: 1 and 2] Review of Riemann-Stieltje's integral, Algebras of sets, Borel subsets of R-Lebesgue Image: Course				1021	L SI LLADUS					
[Course Outcome (s) No.: 1 and 2] Review of Riemann-Stieltje's integral, Algebras of sets, Borel subsets of R-Lebesgue										1
Review of Riemann-Stieltje's integral, Algebras of sets, Borel subsets of R-Lebesgue	Module No.				Content					Hours
	Module No.	Course Outcome (s) No.: 1 and	2]	Content		D	1 1 4		Hours
outer measure and its properties, Algebras of measurable sets in R-nonmeasurable set,	Module No. [(R	Course Outcome (seview of Riemann) No.: 1 and Stieltje's int	2] egral	Content	ets,	Bo	rel subset	s of R-Lebesgue	Hours
I Example of measurable set which is not a Borel set, Lebesgue measure and its 20	Module No.	Course Outcome (s eview of Riemann- uter measure and it) No.: 1 and Stieltje's int s properties,	2] egral Alge	Content , Algebras of s bras of measur	ets, able	Bon set	rel subset: s in R-no	s of R-Lebesgue nmeasurable set,	Hours
properties, Measurable functions.	Module No. [(R o I E	Course Outcome (seview of Riemann- uter measure and it xample of measure) No.: 1 and Stieltje's int s properties, able set wh	2] egral Alge ich i	Content , Algebras of s bras of measur s not a Borel	ets, able set	Bor set	rel subset: s in R-no ebesgue	s of R-Lebesgue nmeasurable set, measure and its	Hours 20
[Course Outcome(s) No.: 3 and 4]	Module No. [(R 01 I E	Course Outcome (seview of Riemann- ater measure and it xample of measure coperties, Measurab) No.: 1 and Stieltje's int s properties, able set wh le functions.	2] egral Alge ich i	Content , Algebras of s bras of measur s not a Borel	ets, able set	Bor set , L	rel subsets s in R-no ebesgue	s of R-Lebesgue nmeasurable set, measure and its	Hours 20
	Module No. [(R o I E p I	Course Outcome (s eview of Riemann- ater measure and it xample of measur coperties, Measurab Course Outcome(s) No.: 1 and Stieltje's int s properties, able set wh le functions. s) No.: 3 and	2] egral Alge ich i	Content , Algebras of s bras of measur s not a Borel	ets, able set	Bor set	rel subsets s in R-no ebesgue	s of R-Lebesgue nmeasurable set, measure and its	Hours 20
Point wise convergence and Convergence in measure, Egoroff theorem, Lebesgue	Module No. [(R 01 1 E p1 [(P 0 1 1 E 1 1 E 1 1 E 1 E 1 1 E 1 E 1 1 E	Course Outcome (seview of Riemann- uter measure and it xample of measure coperties, Measurab Course Outcome(se point wise converge) No.: 1 and Stieltje's int s properties, able set wh le functions. b) No.: 3 and ence and Co	2] egral Alge ich i 1 4]	Content , Algebras of s bras of measur s not a Borel gence in meas	ets, able set ure,	Boi set , L Eg	rel subset: s in R-no ebesgue 1 goroff the	s of R-Lebesgue nmeasurable set, measure and its orem, Lebesgue	Hours 20
Point wise convergence and Convergence in measure, Egoroff theorem, Lebesgue integral, Lebesgue criterion of Riemann integrability, Fatou's lemma, Convergence	Module No. [(R ou I E pu [(Pu im	Course Outcome (seview of Riemann- iter measure and it xample of measure coperties, Measurab Course Outcome(se point wise converge tegral, Lebesgue of) No.: 1 and Stieltje's int s properties, able set wh le functions. s) No.: 3 and ence and Co criterion of 1	2] egral Alge ich i I 4] onver Riem	Content , Algebras of s bras of measur s not a Borel gence in meas ann integrabilit	ets, able set ure,	Bot set , L Eg Fato	rel subsets s in R-no ebesgue goroff the pu's lemm	s of R-Lebesgue nmeasurable set, measure and its orem, Lebesgue	Hours 20
II Point wise convergence and Convergence in measure, Egoroff theorem, Lebesgue integral, Lebesgue criterion of Riemann integrability, Fatou's lemma, Convergence theorem, Differentiation of an integral, Absolute continuity with respect to Lebesgue 20	Module No. [(R O I E p I I I I I I I I I I I I I I I I I	Course Outcome (s eview of Riemann- uter measure and it xample of measur coperties, Measurab Course Outcome(s bint wise converge tegral, Lebesgue c eorem, Differentiat) No.: 1 and Stieltje's int s properties, able set wh le functions. c) No.: 3 and ence and Co criterion of 1 tion of an in	2] egral Alge ich i I 4] onver Riem tegra	Content , Algebras of s bras of measur s not a Borel gence in meas ann integrabilit l, Absolute cor	ets, able set ure, ty,	Bos set , L Eg Fato	rel subsets s in R-no ebesgue 1 goroff the ou's lemm with resp	s of R-Lebesgue nmeasurable set, measure and its corem, Lebesgue na, Convergence pect to Lebesgue	Hours 20 20
II Point wise convergence and Convergence in measure, Egoroff theorem, Lebesgue integral, Lebesgue criterion of Riemann integrability, Fatou's lemma, Convergence theorem, Differentiation of an integral, Absolute continuity with respect to Lebesgue measure, Lebesgue integral in the plane, Fubini's theorem.	Module No. I I I I I I I I I I I I I	Course Outcome (seview of Riemann- ater measure and it xample of measure coperties, Measurab Course Outcome(se point wise converge tegral, Lebesgue of eorem, Differentiat easure, Lebesgue in) No.: 1 and Stieltje's int s properties, able set wh le functions. s) No.: 3 and ence and Co criterion of 1 tion of an in ntegral in the	2] egral Alge ich i I 4] onver Riem tegra plane	Content , Algebras of s bras of measur s not a Borel gence in meas ann integrabilit l, Absolute cor e, Fubini's theor	ets, able set ure, ty, 1	Bor set , L Eg Fatc nity	rel subsets s in R-no ebesgue goroff the pu's lemm with resp	s of R-Lebesgue nmeasurable set, measure and its corem, Lebesgue na, Convergence pect to Lebesgue	Hours 20 20
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 II Point wise convergence and Convergence in measure, Egoroff theorem, Lebesgue integral, Lebesgue criterion of Riemann integrability, Fatou's lemma, Convergence theorem, Differentiation of an integral, Absolute continuity with respect to Lebesgue measure, Lebesgue integral in the plane, Fubini's theorem. 20 Text Books: De Barra, Measure Theory and Integration, Wiley Eastern Ltd., 2013. I. K. Rana, An Introduction to Measure and Integration, Narosa, 2007. 	Module No. I I I I I F II Text Books: > De Barr > I. K. Ra	Course Outcome (s eview of Riemann- uter measure and it xample of measur coperties, Measurab Course Outcome(s bint wise converge tegral, Lebesgue of eorem, Differentiat easure, Lebesgue in ra, Measure Theory na, An Introduction) No.: 1 and Stieltje's int s properties, able set wh le functions. (a) No.: 3 and ence and Co criterion of 1 tion of an in ntegral in the and Integration to Measure	2] egral Alge ich i I 4] onver Riem tegra pland on, V and I	Content , Algebras of s bras of measur s not a Borel gence in meas ann integrabilit l, Absolute cor e, Fubini's theor Viley Eastern La ntegration, Nar	ets, able set ure, ty, 2 ttm. rem.	Bo: set , L Eg Fatc nity 2011	rel subsets s in R-no ebesgue 1 goroff the pu's lemm with resp 3.	s of R-Lebesgue nmeasurable set, measure and its corem, Lebesgue na, Convergence pect to Lebesgue	Hours 20 20
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II Point wise convergence and Convergence in measure, Egoroff theorem, Lebesgue integral, Lebesgue criterion of Riemann integrability, Fatou's lemma, Convergence theorem, Differentiation of an integral, Absolute continuity with respect to Lebesgue measure, Lebesgue integral in the plane, Fubini's theorem. 20 Text Books: > De Barra, Measure Theory and Integration, Wiley Eastern Ltd., 2013. > I. K. Rana, An Introduction to Measure and Integration, Narosa, 2007. Reference Books: > Narosa, 2007.	Module No. I I I I I Text Books: > De Barr > I. K. Ra Reference Boo	Course Outcome (seview of Riemann- iter measure and it xample of measure coperties, Measurab Course Outcome(se bint wise converge tegral, Lebesgue of eorem, Differentiat easure, Lebesgue in ra, Measure Theory na, An Introduction ks:) No.: 1 and Stieltje's int s properties, able set wh le functions. b) No.: 3 and conce and Contribution of an in the set when the set of the set of the content of the set of t	2] egral Alge ich i I 4] onver Riem tegra pland on, V and I	Content , Algebras of s bras of measur s not a Borel gence in meas ann integrabilit l, Absolute cor e, Fubini's theor Viley Eastern Lu ntegration, Nar	ets, able set ure, ty, 1 ntinu rem.	Boi set , L Eg Fatc ity 2011	rel subset: s in R-no ebesgue 1 goroff the ou's lemm with resp 3.	s of R-Lebesgue nmeasurable set, measure and its corem, Lebesgue na, Convergence pect to Lebesgue	Hours 20 20
II Point wise convergence and Convergence in measure, Egoroff theorem, Lebesgue integral, Lebesgue criterion of Riemann integrability, Fatou's lemma, Convergence theorem, Differentiation of an integral, Absolute continuity with respect to Lebesgue measure, Lebesgue integral in the plane, Fubini's theorem. 20 Text Books: > De Barra, Measure Theory and Integration, Wiley Eastern Ltd., 2013. > I. K. Rana, An Introduction to Measure and Integration, Narosa, 2007. Reference Books: > H. L. Royden, Real Analysis, Prentice Hall India Learning, 2011.	Module No. [(R OT I E pr [(Pd II m Text Books: > De Barr > I. K. Ra Reference Boo > H. L. R	Course Outcome (seview of Riemann- ater measure and it xample of measure coperties, Measurab Course Outcome(se point wise converge tegral, Lebesgue of eorem, Differentiate easure, Lebesgue in ra, Measure Theory na, An Introduction ks: oyden, Real Analys) No.: 1 and Stieltje's int s properties, able set wh le functions. s) No.: 3 and ence and Co criterion of 1 tion of an in ntegral in the and Integration to Measure is, Prentice F	2] egral Alge ich i I 4] onver Riem tegra pland on, V and I Hall In	Content , Algebras of s bras of measur s not a Borel gence in meas ann integrabilit l, Absolute cor e, Fubini's theor Viley Eastern La ntegration, Nare	ets, able set ure, ty, 1 ttinu td., 2 osa,	Bor set , L Eg Fatc nity 2011	rel subsets s in R-no ebesgue goroff the ou's lemm with resp 3.	s of R-Lebesgue nmeasurable set, measure and its orem, Lebesgue na, Convergence pect to Lebesgue	Hours 20 20
 Point vise convergence and Convergence in measure, Egoroff theorem, Lebesgue integral, Lebesgue criterion of Riemann integrability, Fatou's lemma, Convergence theorem, Differentiation of an integral, Absolute continuity with respect to Lebesgue measure, Lebesgue integral in the plane, Fubini's theorem. Text Books: > De Barra, Measure Theory and Integration, Wiley Eastern Ltd., 2013. > I. K. Rana, An Introduction to Measure and Integration, Narosa, 2007. Reference Books: > H. L. Royden, Real Analysis, Prentice Hall India Learning, 2011. > P. K. Jain & V. P. Gupta, Lebesgue Measure and Integration, New Age International (P) Ltd., 2006. 	Module No. I I F Module No. (C R O P H II M M M M M M M M M M M M M	Course Outcome (s eview of Riemann- iter measure and it xample of measur coperties, Measurab Course Outcome(s bint wise converge tegral, Lebesgue of eorem, Differentiat easure, Lebesgue in ra, Measure Theory na, An Introduction ks: oyden, Real Analys in & V. P. Gupta, L) No.: 1 and Stieltje's int s properties, able set wh le functions. b) No.: 3 and ence and Co criterion of 1 tion of an in ategral in the and Integration to Measure is, Prentice Hebesgue Mea	2] egral Alge ich i ich i I 4] onver Riem tegra pland on, V and I and I Hall In	Content , Algebras of s bras of measur s not a Borel gence in meas ann integrabilit l, Absolute cor e, Fubini's theor Viley Eastern La ntegration, Nard	ets, able set ure, ty, 1 td., 2 td., 2 0011	Bor set , L Eg Fatc ity 2011 2001	rel subsets s in R-no ebesgue 1 goroff the pu's lemm with resp 3. 07.	s of R-Lebesgue nmeasurable set, measure and its corem, Lebesgue na, Convergence pect to Lebesgue	Hours 20 20 20 2006.

Course No:	14	Course Name	: Fixed Poin	t The	eory	Cou	rse Co	ode: MM	AE 0015	
Batch:		Programme: M.Sc.	Semester:	L	Т	Р	J	Credit	ts Contact Hrs Per Week:4	
2024-2026		Mathematics	IV	4	0	0	0	4	Total Hours: 4	0
Total Evalua	ation I	Marks: 100	Examinatio	on Di	iration:	Mid	Term	(2 hours)), End Term (3 hou	rs)
Theory Asso Internal Ass	essme	nt: 75 Marks	Pre-requisi	te of	course:	Func	ctional	Analysis		
Course	This	course will dev	l relon a profo	und i	Inderstar	nding	of Ba	nach's co	ntraction principle	Caristi-
Objective	Ekela	nd principle and	d other relate	d res	ults The	stude	ents w	ill learn th	ne concepts of hype	r convex
Objective	space	s and normal s	structures in	metr	ic space	s. Fu	rther.	a deep u	nderstanding of co	ntinuous
	mapp	ings defined of	n metric spa	ces a	nd fixed	l poir	nt set	structures	s will be developed	1 in this
	cours	e. This course f	ocuses on em	ploya	ability ar	d ski	ll deve	elopment a	aligned with all CO	's.
	After	studving these	topics, the st	udent	s will be	able	to:	-1	8	
	CO1:	Understand Ba	mach's contra	action	1 princip	le, its	extens	sion and a	opplications.	
Course	CO2 :	Learn hyper co	onvex spaces	and t	heir char	acteri	istics.		11	
Outcomes	CO3:	Understand fix	ted point theo	orem	and knov	v the	structu	ire of the	fixed point set.	
	CO4:	Determine the	continuous n	nappi	ng betwe	een B	anach	spaces.	I	
	CO5:	Learn Brouwe	r's theorem, S	Schau	ider's the	eorem	n and r	elated res	ults.	
	CO6:	Apply various	mappings of	metr	ic fixed p	ooint	theory			
			COU	JRSI	E SYLL	ABU	S			
Module No.					Conten	ıt				Hours
I	Metri Banac princi Hype Prope Norm Fixed	ic Contraction ch's principle, ' iple, set valued or convex Space erties of hyper al structures in point set struct	Principles: The Caristis contractions, ces and Nor convex space metric space ure, Separabl	Bana Ekela Gene mal S es, A s, Fix le cas	ach's con and princ eralized c Structur fixed point e.	ntract ciple, contra es in pint t theor	ion pr Equiv ctions Metr heoren rem, St	inciple, F alents of ic Spaces n, Approx tructure o	Further extension of the Caristi-Ekeland s: Hyper convexity kimate fixed points f the fixed point set	20
П	[Cou Conti Brouv Schau Metr mapp	rse Outcome(s inuous Mappin wer's theorem, uder degree, Cos ic Fixed Point ings, Structure ings.	s) No.: 4, 5 ang in Banac Schauder's ndensing map Theory: Con of the fixed p	nd 6 h Sp theo oping ntract] aces: Br rem, Sta s, Contir ion map set, Asyr	ouwe Ibility Iuous pings mptot	er's the of S mappi , Basic ically	eorem, Fu chauder's ings in hy c theorem regular m	arther comments or s theorem, Leray - per convex spaces. s for non-expansive nappings, Set valued	20
Text Book:	•									
M. A Inters	A. Kha science	msi & W. A. Ki e, 2001.	irk, An Introc	luctio	on to Met	ric S _j	paces a	and Fixed	Point Theory, Wile	у-
Reference B	ooks:									
 E. Ze D. R V. I. Q. H Inter 	eidler, . Smar Istrate I. Ans nation	Nonlinear Func rt, Fixed Point T escu, Fixed Poir ari, Metric Spa al, 2010.	ctional Analy Theory, Camb at theory: An aces Includin	sis ar oridge Intro Ig Fiz	nd its Appe Universe duction, ked Poin	plicat sity P Sprin t The	ions, S ress, 1 ger, 20 eory ai	Springer-V 980. 001. nd Set-Va	/erlag, 1998. alued Maps, Alpha	Science

Course No:	15	Course Nam	e: Finite Elei	nent	Method	Cou	rse Co	de: MMAE	E 0016	
Batch:		Programme: M.Sc.	Semester:	L	Т	Р	J	Credits	Contact Hrs Per Week:4	
2024-2026		Mathematics	IV	4	0	0	0	4	Total Hours: 4	0
Total Evalua	tion N	Jarks: 100	Examinatio	on Dı	iration:	Mid	Term	(2 hours), H	End Term (3 hour	rs)
Theory Asse Internal Ass	essme sessme	nt: 75 Marks ent: 25 Marks	Pre-requisi	te of	course:	Num	erical	Analysis		
Course Objective	The c incluc course solvin develo	course aims to ling shape func e objective is to ag various bou	provide the tions and ger to acquaint t ndary value with all CO'	fund neral he st prob s.	lamental linear an udents a blems. T	conc d hig bout his c	epts o her ord applic ourse	f the finite der elements ation of fir focuses on	element method s up to 2 dimensionite element method employability a	mainly ons. The hods for nd skill
Course Outcomes	After CO1: CO2: CO3: CO4:	studying these Understand the difference met Use the role and linear, quadrate Formulate som Apply the weig problems.	topics, the stu e general the hod hd significan- ic, and cubic ie important ghted residua	ident eory ce of shap 1, 2 a 1 and	s will be of Finite shape fu e function nd 3 dim variation	able Eler inctio ons fo iensio nal ap	to: ment n ns in fi r interp nal ele proach	nethod and inite elemer polation ements nes in solvin	its difference wi at formulations an g some boundary	th finite d use of value
			COU	JRSE	ESYLL	ABU	S			
Module No.					Conter	nt				Hours
I	[Cou Introd one conne constr dimer	rse Outcome(seluction to finite dimensional finite ectivity, boundar cuction of shap	b) No.: 1, 2 a element me nite elemen ary condition be functions: ar and rectan	thods ts, c s, ar linea gular] concept ad equili ar eleme element	ot of c of s briun nts (o s).	liscreti hape n equa one di	zation, diffe functions, ttion. Nume mensional	erent coordinates, stiffness matrix, erical integration, bar element, two	20
п	[Cou Weigl Rayle eleme for fir	rse Outcome(s hted residual a igh Ritz metho ent methods for hite element ana	s) No.: 3 and nd variationa od etc.), Solv solving var lysis.	1 4] al app ving o ious	proaches one-dime boundar	(Gal ension y valu	erkin : nal pro ue prol	method, col oblems. App blems, Com	llocation method, blication of finite nputer procedures	20
 Text Books: S. S. Rao, The Finite Element Method in Engineering, Butterworth-Heinemann, 2010. T. J. R. Hughes, The Finite Element Method (Linear Static and Dynamic Finite Element Analysis Courier Corporation, 2007. 							rsis).			
Reference B → O. C. 2000.	o ok: Zienk	iewicz & R. L.	Taylor. The	Finite	Elemen	t Met	hod: T	he Basis, B	utterworth-Heiner	mann,

Course No:	16	Course Nam	e: Operational R	esearc	ch-II	Cour	se C	Code: MM	IAE 0017	
Batch:		Programme: M.Sc.	Semester:	L	Т	Р	J	Credits	Contact Hrs Per Week:4	
2024-2026		Mathematics	III/IV	4	0	0	0	4	Total Hours: 4	0
Total Evalua	ation 1	Marks: 100	Examination I	Durati	ion: Mi	id Ter	m (2	hours), E	and Term (3 hour	rs)
Theory Asso Internal Ass	essme sessm	ent: 75 Marks ent: 25 Marks	Pre-requisite o	of cou	rse: Op	oeratio	nal I	Research	- I	
Course Objective	This queui progr this c	course will deve ing models. Fu amming evalua ourse. This cour	elop a profound rther, a deep u tion and review rse focuses on en	under nderst techn nploya	standing anding ique (P ability a	g of in of ne ERT) nd ski	vento etwor and 11 dev	ory contro k diagrar cost analy velopment	I models and Man, critical path rsis will be deve aligned with all	arkovian method, loped in CO's.
Course Outcomes	After CO1 CO2 CO3 CO4	studying these to Understand cri related concept Learn EOQ and Understand pro	copics, the studer tical path methor s. d deterministic in babilistic model cs of queuing the	nts wil d, prog nventc ls of ir eory ar	l be abl grammi ory mod nventory nd unde	e to: ng eva els. y contr rstand	luati ol. Mar	on and rev kovian qu	view technique an euing models.	nd other
			COURS	SE SY	LLAB	US				-
Module No.				Co	ntent					Hours
I	[Cou CPM Critic evalu and C Inver mode	and PERT: Int al events and Ad ation and Review crashing the network htory Control I Is, Deterministic	b) No.: 1 and 2] roduction, Netwo ctivities, Critical v technique (PER ork, Resource scl : General invent inventory model	ork dia path n T), Re hedulin tory n s-prod	ngram, E nethod (esources ng. nodel, S uction n	Events (CPM) and m static endel-1	and A , Floa aan po econc Buffe	Activities, at, Slack, a ower level omic order er stock.	Project planning, and Programming ing, Cost analysis quantity (EOQ)	20
П	[Cou Inver Queu Gener M/M/	rse Outcome(s ntory Control II ing Theory: In ral birth-death ea /c, M/M/1/k, M/N	F) No.: 3 and 4] Price break mode troduction to que quation, Steady-s M/c/k).	lels, Pi euing tate sc	robabilis models, plution o	stic Mo Basic of Mar	odels com kovia	-Newspape ponents of an queuing	er boy problem. F queuing system, g models (M/M/1,	20
Text Books: → P. K. G → J. K. Sh → K. Swa Reference Bo	upta & narma, rup, P ooks:	2 D. S. Hira, Ope Operations Rese . K. Gupta & M.	erations Research earch Theory and Mohan, Operatio	, S. Ch Appli ons Res	and & (cations, search, S	Co., 20 Macm Sultan	008. illian Chan	India Ltd Id & Sons,	., 2016. 2010.	1

- S. D. Sharma, Operations Research, Kedar Nath & Ram Nath Publications, 2012.
 H. A. Taha, Operations Research: An Introduction, Pearson Education, 2010.
 D. Chatterjee, Linear Programming and Game Theory, Prentice Hall, India, 2006.

Course No:	17	Course Name	: Fractional	Calc	ulus	Cours	e Cod	e: MMAE (0018	
Batch:		Programme: M.Sc.	Semester:	L	Т	Р	J	Credits	Contact Hrs Per Week:4	
2024-2026		Mathematics	IV	4	0	0	0	4	Total Hours: 4	0
Total Evalu	ation I	Marks: 100	Examinatio	on Di	iratio	n: Mid	Term	(2 hours), E	End Term (3 hour	rs)
Theory Ass Internal As	essme sessm	nt: 75 Marks ent: 25 Marks	Pre-requisi	te of	cours	se: Diffe	erentia	l Equations,	Numerical Analy	vsis
Course Objective	This and the solution	course will dev heir Laplace tra on of fractional	velop a profo ansform. Fur differential d skill develor	und ther, equat	unders a deej ions w t align	tanding p under fill be de ed with	of fra standin evelop all CC	ctional integration integration of numeric of numeric of numeric of the second state o	gral, fractional de rical methods to ourse. This course	erivative find the focuses
Course Outcomes	After CO1: CO2: CO3: CO4: CO5:	studying these Know the cond Understand the Evaluate Lapla Apply the num Solve real-life	topics, the stucept of Euler' e fractional ir ace transform perical metho fractional nor	ident s and tegra of fr ds in ilinea	s will I Mitta Il and o actiona solvin <u>or mod</u> E SYI	be able g-Leffle derivativ al integr g fractio els.	to: er Fund ves. rals and onal di	ction. d derivatives fferential eq	s. uations.	
Module No.					Cont	ent	~			Hours
I	[Course of the second s	rse Outcome(s) al Functions g-Leffler functi- tional Calculus kovfractional d its properties, L ice transform of) No.: 1, 2 an – Euler's fu ons. – Introductio erivative,Rie iouville-Cap fractional int	d 3] nctio n, De mann uto fr tegral	ns, In efinition -Liouv action	tegral f on, Frac ville (R al deriv derivati	functio tional f L) frac vative c ves.	ns, One and integral of o octional derived of order α w	d two parameter rder α ,Grünwald– vative of order α vith its properties,	20
II	[Cou Fract differ nonlin (ADN fraction method	rse Outcome(stional Different ential equations near fractional (A), Fractional onal differentiational od (FVIM).	s) No.: 3 and tial Equatio s, Existence differential e systems of l equations,N	I 4] ns (I and quation diffee Nume	(DE) – unique on, So erentia erical	Riema eness fo lution b l equat solution	nn-Lic or the oy Adc ions, by fr	ouville and (Caputo prob omian decon Time-fraction actional van	Caputo fractional olem, Linear and nposition method onal and Space- riational iteration	20
Text Books:	Milici nlinear A. Kil uations	, G. Draganesc r Systems and C bas, H. M. Sriv s, Elsevier B.V.	uand & J. T Complexity, S vastava & J. , Amsterdam	. Ma pring J. Tr , 200	chado, ger Nat ujillo, 6.	Introdu ture Swi Theory	uction itzerlai and A	to Fractionand AG, 2019	al Differential Eq). of Fractional Dif	uations: ferential
Reference B → I. F → E. 1 201	ooks: Podlubi Don, S 18	ny, Fractional D chaum's Outlin	Differential Ec	quatio	ons, Adand the	cademic e Wolfr	c Press am La	, 1999. nguage, Mc	Graw Hill Educat	tion,

Course No: 1	18	Course Name	: Mathematic	cal M	odeling	Cou	rse Co	ode: MMAE	0019	
Batch:		Programme: M.Sc.	Semester:	L	Т	Р	J	Credits	Contact Hrs Per Week:4	
2024-2026		Mathematics	IV	4	0	0	0	4	Total Hours: 4	0
Total Evalua	tion I	Marks: 100	Examinatio	on Du	iration:	Mid	Term	(2 hours), E	End Term (3 hour	rs)
Theory Asse Internal Ass	essme	nt: 75 Marks ent: 25 Marks	Pre-requisi	te of	course:	Ordi	nary a	nd Partial Di	fferential equation	ons
Course	This o	course provides	introduction	of m	athemati	cal n	nodelir	g and analys	sis in biological s	ciences.
Objective	The r funda incluc This c	najor content o mentals of dete les both linear course focuses o	f this course rministic mo- and non-line on employabi	is cł dels i ear m lity a	nosen fro n both di odels wi nd skill o	om po iscret ith su levelo	opulati e and o opmen	on dynamics continuous ti at amount of t aligned wit	s. This course co me domains. Thi f theoretical back h all CO's.	overs the s course ground.
	After	studying these	topics, the stu	ıdent	s will be	able	to:			
Course	CO1:	Understand t	he mathema	tical	model a	and e	explain	the series	of steps involv	ed in a
Outcomos	aaa	mathematical	modeling pro	cess.	1 1			1. 00		
Outcomes	CO2: CO3: CO4:	Apply the cond linear and disc Use applicatio limitations of Apply mathem	ept of mathe rete time nor ns of mather mathematics atical model	matic nlinea natica in so ing in	cal mode ar models al model lving pra	ling t 5. ing a ctical ous ti	hrough nd ma l real-l me mo	h difference of ke students a ife problems odels.	equations in discr appreciate the po	wer and
			COU	URSI	ESYLLA	ABU	S			
Module No.					Conten	t				Hours
I	[Cours Overv solve Prey-j linear struct Discre Stabil	rse Outcome(s) view of mathem them, Discrete predator model difference equ ured model – L ete time non-line	No.: 1 and 2 natical mode time linear 1 , Analytical ations, Grap eslie Model, near models- r discrete tim	2] Iing, mode solut hical Jury' Diffe	Types c ls – Fibo ion meth solution s stabilit erent cell dels Lo	f ma onacc ods a – Co y test l divi	thematic i rabbic and stand obweb sion n differe	tical models it model, Ce ability analy diagrams, I nodels, Prey	and methods to ll-growth model, sis of system of Discrete time age -predator model,	20
		rse Outcome	$\frac{1}{2}$ No \cdot 3 and		dels, Lo	Sistic	uniter	chee equation		
п	Introc mode micro differ Conti	luction to conti l, Need of conti organisms, Che ential equations nuous time sing	nuous time n nuous time n emostat, Stab gle species m	node nodel ility odel	ls – Lim s, Contir and linea – Allee e	itatio nuous arizati effect	ons and time r ion me	l Advantage nodels – mo ethods for sy itative soluti	of discrete time del for growth of stem of ordinary on of differential	20
	equat mode	ions using phas l, Prey predator	e diagrams, (models.	Conti	nuous tii	ne m	odels	– Lotka-Vol	terra competition	
Text Books:	1	_								ı
 J. N. 1 M. M A. Ru R. J. 1 	Kapur . Mee therfo Elliott	, Mathematical rschaert, Mathe ord, Mathematic & P. E. Kopp,	Modelling, N matical Mode al Modelling Mathematics	New A elling Tech of Fi	Age Inter Acader niques. nancial M	natio nic P Couri Marke	nal, 20 ress, 2 ier Cor ets. Sp	15. 013. poration, 20 ringer Verlag	12. g, New York Inc,	2018.
Reference I	Rooke									
➢ L. D.➢ E. A.	Clive, Bende	, Principles of N er, An Introduct	Iathematical ion to Mathe	Mod matic	elling, E al Mode	lsevie lling,	er, 200 Couri	4. er Corporatio	on, 2000.	

Course No:	19 Course Nam	e: Fuzzy Set	Theo	ry	Cours	se Cod	le: MMAE (0020	
Batch:	Programme: M.Sc.	Semester:	L	Т	Р	J	Credits	Contact Hrs Per Week:4	
2024-2026	Mathematics	III/IV	4	0	0	0	4	Total Hours: 4	0
Total Evalua	ation Marks: 100	Examinatio	on Di	iratio	n: Mid	Term	(2 hours), I	End Term (3 hou	rs)
Theory Asso Internal Ass	e ssment : 75 Marks sessment: 25 Marks	Pre-requis	ite of	cours	se: Disc	rete M	athematics		
Course	In this course, we s	tudy about th	e app	licatio	ons of i	ntegral	equations i	n real life proble	ms. The
Objective	main objective of th	e course is to	mak	e the l	learner t	familia	rize with th	e types of kernel,	, and the
Ū	solution of integral	equations usi	ng va	rious	method	s. Diff	erential equ	ations can be stu	idied for
	their solutions by tra	ansforming th	em in	to inte	egro-dif	ferenti	al equations	using Laplace tra	ansform
	This course focuses	on employabi	lity a	nd ski	ll devel	opmen	t aligned wi	th all CO's.	
	After studying these	topics, the stud	lents	will be	able to:				
Course	CO1: Use the conce	ept of differen	nt ker	nels a	nd tech	niques	for solving	various kinds of	integra
Course	equations.								
Outcomes	CO2: Determine use	of integral equ	lation	S.	1				
	CO3: Recognizeto co	o-relate differe	ential	and int	tegral eq	uation	S.		
	CO4: Solve Integral	col	JRSI	E SYL		<u>s.</u> S			
Module No.				Cont	ent				Hours
	[Course Outcome($(\mathbf{x}) \mathbf{N} \mathbf{a} \cdot 1$ and	2 1						
	Fuzzy set Standard	operations of	∠] `fuzz	v set	Fuzzy c	omnle	ment Fuzzy	union and fuzzy	r
	intersection other	operations in	fuzz	y set	t_norn	ns and	t_conorms	Interval Fuzzy	7
т	number Operation	of interval of	norati	on of	cut ir	no and	Operation	of triangular and	20
1	number, Operation				- Cut II			01 utaligutat allu	
	general luzzy num	bers, Approxi	matic		uriangui	ar and	rapezoida	i iuzzy numbers,	•
	Bell shape fuzzy nu	imber, Functi	on w	ith fuz	zy cons	straint,	Propagation	n of fuzziness by	7
	crisp function, Fuzz	zifying function	on of	crisp	variabl	e, max	timizing and	d minimizing set,	,
	maximum value of c	crisp function.							
	Course Outcome	(s) No.: 3 and	d 4]		c			1 01 1 1	
	Integration and d	ifferentiation	of	fuzzy	funct	ion p	roduct set,	definition and	L
	characteristics of re	lation, repres	entati	on me	thods o	f relat	ions, operat	ions on relations,	20
	path and connect	ivity in gra	ph,	funda	mental	prope	rties, equiv	valence relation,	20
	compatibility relation	on, pre-order	relat	ion, o	rder re	lation,	definition	and examples of	-
	fuzzy relation, fuz	zy matrix, o	perat	ions c	on fuzz	y rela	tion. Comp	osition of fuzzy	r
	relation, - cut of f	uzzy relation	, pro	jectior	n and c	ylindr	ical extensi	on, extension by	r
	relation, extension r	principle, exte	nsion	bv fu	zzv rela	• ation. f	fuzzy distan	ce between fuzzy	7
	sets, graph and fuzz	v graph fuzzy	/ gran	h and	fuzzy re	elation	- cut of fuz	zv graph	
Text Books:	Seto, Bruph und Tuzz	orupii, iuzz)	Srup		1022 J IV		, catoriuz	~, 5. mp	L
\succ C. M	ohan, An Introductio	n to Fuzzy Se	t The	ory an	d Fuzzv	/ Logic	. Anshan Pu	ublishers, 2015.	
► K. H.	Lee, First Course or	Fuzzy Theor	y and	Appl	ications	, Sprin	ger, 2005.	· · · · · · , · · · · ·	
Roforonco De	ale.								
	n & R Langari Fuzz	v Logic - Inte	llioe	ice C	ontrola	nd Infe	rmation Pe	arson Education	1999
→ H.J	Zimmerman. Fuzzy	Set Theory an	d its	Applic	ations.	Allied	Publishers I	td New Delhi	1991.
11.01	, i all j ,	and any an		TLU				,	

Course No:	20 Course Name: N	Jumerics of Ordinary Diff	erent	ial	Cou	rse C	ode: MM	IAE 0021						
		quations	.											
Batch:	Programme: M.Sc.	Semester:		Т	P	J	Credits	Per Wee	Hrs ek:4					
2024-2026	Mathematics	III/IV	4	0	0	0	4	Total Ho	ours: 40					
Total Evalu	ation Marks: 100	Examination Duration:	Mid	Tern	n (2 ł	nours)	, End Te	rm (3 hou	rs)					
Theory Ass	essment: 75 Marks		0.1		D'00									
Internal As	sessment: 25 Marks	Pre-requisite of course:	Ana	nary lysis	Diffe	rentia	I Equation	ns, Numer	ical					
Course	This Course will dev	velop a profound understan	nding	of c	ne-st	ep an	d multi-s	tep metho	ds along					
Objective	with their consisten	cy convergence and stabil	ity. F	Furthe	er a l	basic	understar	nding of b	oundary					
	value problems and	their solutions will be de	velop	co^{2}	n this	s cour	se. This	course for	cuses on					
	After studying these	topics, the students will be	un an abla i	<u></u>	5.									
	CO1 . classify the di	fferential equation like line	able i	.0. m_lir	ear]	IVP or	r BVP							
Course	CO2: Solve the dif	ferent type of differentia	l eau	ation	s nu	meric	ally who	se solution	n is not					
Outcomes	necessarily giv	necessarily given.												
	CO3: Check the con	sistency and stability of any	y num	nerica	al me	thod								
	CO4: Construct high	ner order numerical method	for I	VPs.										
		COURSE SYLL	ABU	S										
Module No.		Conten	t						Hours					
	[Course Outcome(s]) No.: 1 and 2]												
	Approximation of in	nitial value problem for c	ordina	ry di	iffere	ntial	equations	: one-step						
Ι	methods including th	he explicit and implicit Eu	ler m	etho	ds, th	e trap	ezium ru	le method	20					
	and Runge-Kutta me	ethods. Linear Multi-step 1	metho	ods: o	consi	stency	, zero sta	ability and						
	convergence, absolut	te stability.												
	[Course Outcome(s) No.: 3 and 4]												
	Predictor-corrector	methods, stiffness, stabilit	y reg	gions	, Ge	ar's n	nethods	and their						
II	implementation. Nor	linear stability.							20					
	Boundary value prob	lems: shooting methods, m	atrix	meth	ods c	olloca	ation.							
Text Books:														
➤ H. B.	. Keller, Numerical m	ethods for Two-point Boun	dry V	alue	Prob	lems,	SIAM, 19	976.						
➢ J. D.	Lambert, Computatio	nal Methods in Ordinary D	iffere	ntial	Equa	tions,	John Wil	ey & Sons,	1991.					
Reference B	ooks:													
≻ L. E	. Hairer, S. P. Nors	sett & G. Wanner, Solvir	ng On	rdina	ry D	iffere	ntial Equ	ations I:	Nonstiff					
Prob	lems, Springer-Verlag	, 1987.	-		-		_							
➢ P. He	enrici, Discrete Variab	ble Methods in Ordinary Di	fferen	tial I	Equat	ions,	Wiley, 19	62.						
≻ K. W	. Morton, Numerical	Solution of Ordinary Diffe	rentia	al Ea	uatio	ns, Öz	xford Uni	versity Co	mputing					
Labo	ratory, 1987.	<u> </u>		1		,		•						
> A. M	l. Staurt & A. R. Hum	phries, Dynamical Systems	s and	Num	erica	l Ana	lysis. Car	nbridge Ui	niversity					
Press	s, 1996.	· / / · · · · · · · · · · · · · · · · ·					, .,	-6- 5-						

Course	No: 2	21	Course Name	: Numerics of	of Par	rtial	Cours	e Cod	e: MMAE (0022	
				Differentia	I Equ	ations			~		
Batch:			Programme: M.Sc.	Semester:	L	Т	Р	J	Credits	Contact Hrs Per Week:4	
2024-20	026		Mathematics	IV	4	0	0	0	4	Total Hours: 4)
Total E	Zvalua	tion I	Marks: 100	Examinatio	on Du	iratio	n: Mid	Term	(2 hours), l	End Term (3 hour	rs)
Theory Interna	v Asse al Ass	ssme essm	nt: 75 Marks ent: 25 Marks	Pre-requisi	te of	cours	e: Parti Ana	al Diff lysis	erential Equ	ations, Numerica	1
Course Objecti	ive	This differ exam under will b aligne	course will de ential equations ine the consiste standing of fini- be developed in ed with all CO's	velop a prof s and initial ncy and conv ite element n this course.	ound and erger netho This	under bounds nee of s ds to f cours	rstandir ary val solutior ind the e focus	ng of f ue pro us and a solution es on	finite differ blems. The analyze thei on of ordin employabil	ence schemes for students will be r stability. Further ary differential ec ity and skill deve	r partial able to ; a deep juations, lopment
Course Outcon	e nes	After CO1: CO2: CO3: CO4:	studying these Understand fin Examine consi Know finite problems. Learn finite eld	topics, the stu ite difference stency, stabil difference s ement method	udenta e sche lity ar chem ds to	s will the series to the series to solve of t	be able find the vergence find the find the	to: ne solu ne of so ne solu v differ	tion of parti dutions. ation of ini ential equat	al differential equ tial and boundar ions.	ations. y value
				COI	JRSF	ESYL	LABU	S	1		
Modul	e No.					Cont	ent				Hours
I		[Cou Finite Backy of fin for tw	rse Outcome(s) Differences, F ward Euler and ite difference s to dimensional	No.: 1 and inite differen Crank-Nicol cheme by Vo heat conducti	2] Ice sc Ison s Ion Ne	hemes cheme cumanr juation	for inits, Stab	tial val ility, C od and	ue problem Consistency matrix met	s, Explicit FTCS, and Convergence hod, ADI scheme	20
п	[[Cou Finite for or Fried of we	rse Outcome(s difference solu- ne dimensional richs-Lewy (CF ighted residuals	s) No.: 3 and ation of Lapl wave equation L) conditions b, Variational	1 4] ace a on, L s, Fin meth	nd Poi ax We ite eler ods.	sson's ndroff nent m	equation methoo ethod f	ons, Finite c d, Upwind for two poin	lifference scheme scheme, Courant- t BVP, Method	20
Text Bo	00ks: G. D. J. C. S J. N. I	Smith Strikw Reddy	n, Numerical So rerda, Finite Dif r, An Introductio	lutions to Pa ference Sche on to Finite E	rtial I mes a Eleme	Differe and Par nt Met	ntial Ec rtial Di hod, M	uation fferent cGraw	s, Oxford U ial Equation Hill, 2005.	Iniversity Press, 19 Is, SIAM, 2004.	986.
Referen	nce Bo L. La Engin K. W Unive C. Jo Dover	ooks: pidus eering . Mor rsity l hnson : Publ	& G. F. Pind g, John Wiley, 1 ton & D. F. M Press, 2005. , Numerical So ications, 2009.	er, Numerica 982. Iayers, Num plutions to F	al Sol erical Partial	lutions Solut Diffe	to Par ions to rential	rtial D Partia Equati	ifferential H I Different ions by the	Equations in Scie ial Equations, Ca Finite Element 2	nce and mbridge Method,

Course No:	22	Course Name	: Mathemati	cs fo	r Finance	Cour	se Co	de: MMA	AE 0023			
Batch:		Programme: M.Sc.	Semester:	L	Т	Р	J	Credits	Contact Hrs Per Week:4			
2024-2026		Mathematics	II/III/IV	4	0	0	0	4	Total Hours: 4	0		
Total Evalu	ation 1	Marks: 100	Examinatio	on Du	iration: N	/id Te	erm (2	hours), l	End Term (3 hou	rs)		
Theory Ass	sessme	nt: 75 Marks										
Internal As	sessm	ent: 25 Marks	Pre-requisi	ite of	course: N	Jil						
Course	This	course will dev	velop a profo	ound	understand	ling o	f finar	icial man	agement theory a	and time		
Objective	value	of money. The	e students w	ill be	able to f	ind ou	it the	cost of a	capital and lear	n capital		
	budge	eting technique	s. Further, a	a dee	p understa	anding	g of ca	apital str	ucture theoreis,	dividend		
	polici	ies and invento	ry managem	ent te	echniques	will b	e deve	eloped in	this course. Thi	is course		
	tocus	es on employab	oility and skill	l deve	elopment a	lignec	with a	all CO's.				
	After	r studying these	topics, the st	uden f fina	ts will be a	ible to	: a tima	value of	monay raturn an	d rick oc		
	COL	the building b	g the basic of locks of finar	i iiia ice th	eorv		e unic	value of 1	money, return, an	lu 115K as		
Course	CO ₂	: Identifying the	e financial vi	abilit	v of a capi	tal bu	dgeting	e exercise	e in various situat	ions and		
Outcomes		application in	decision mak	cing.) F-			5				
	CO3	: Identifying the	various cost	of ca	pital its co	mpon	ent and	d method	s of calculation.			
	CO4	: Understand th	stand the theories of the relationship between capital structure and the va									
	~~~	firm.										
	CO5	: Outlining the	issues of d	sues of dividend policy and the logic of dividend relevance								
	COG	irrelevance.	man to man		a ant to alan							
		Applying the I	nventory mai			Iques.						
Madula Na			COL	JNSI	Contont	DUS				Hanna		
	•		No.1.2 am	1 21	Content					Hours		
	[Cou Final	rse Outcome(s	) INO.: 1, $2$ all nent $-$ Introd	l <b>u 5</b> j ductiv	on Nature	and	scone	of finand	rial management			
	Goals	and main decis	sions of finan	cial r	nanageme	nt.	scope	Of Illian	nar management	,		
т	Time	value of Mon	ey – Time pre	eferer	ice for mo	ney, F	resent	value an	d Future value of	f 20		
-	mone	y, Annuities an	d its kinds.									
	Cost	of Capital: Co	ncept and me	easure	ement of c	ost of	Capita	l, Debt v	s. Equity, Cost of	f		
	equit	y, Cost of prefe	erence shares	, Cos	t of retain	ed ear	nings.	Weighte	d average cost of	f		
	capita	al (WACC) and	Marginal cos	st of c	capital.		NT	1		1		
	Capi	tal Budgeting:	Introduction,	, inve	stment dec	21810n,		e and tec	f uniques of capital	1		
	budge	ting, Tradition	al methods: F	ayba		metho	d, Ave	rage rate	or return method	,		
	1 ime	-adjusted metho	bas: Net pres	ent v	aiue, Inter	nai ra	te of r	eturn met	nod, Profitability	/		
	index	method, Disco	unted paybac	к per	10d metho	a.				<b> </b>		
		rse Outcome(	s) No.: 4, 5 a	ind 6		<i>a</i>			~			
	Capi	tal Structure I	<b>Decisions</b> : Ca	ipital	structure	vs. fin	ancial	structure	– Capitalization	,		
п	Level	rages: Financial	l leverage, O	perati	ing leverag	ge and	Com	posite lev	erage. EBIT-EPS	20		
11	Theor	ries – The Modi	oliani miller t	of financial leverage.								
	Divid	lend Decisions	Dividends a	and v	alue of the	e firm.	Relev	ance of d	lividends. Factors			
	deter	mining dividen	d policy, div	viden	d and val	uation	of th	e firm-T	he basic models	:		
	Walte	er model and Go	ordon model.									
	Inver	ntory Manage	ement: Mea	ning	and imp	ortanc	e; Da	angers of	f excessive and	1		
	inade	y; Techniqu	es of	f inventor	y ma	nagem	ent viz.	Economic order	r			
	quant	lysis techniqu	ie.									
	Uses	ot excel in final	ncial manage	ment	•							

- > I. M. Pandey, Financial Management, Vikas Publishing House, 2015.
- > R. M. Kishore, Financial Management- Theory, Problem, Cases, Taxmann Publication, 2020.

- > M. Y. Khan & P. K. Jain, Financial Management, Tata McGraw-Hill Publication, 2018.
- > P. Chandra, Financial management, Tata McGraw-Hill Publication, 2011.
- R. Brealey, S. Mayers, F. Allen, & P. Mohanty, Principle of Corporate Finance, Tata McGraw-Hill Publication, 2018.
- S. N. Maheswari, Financial Management, Vikas Publishers, 2007.

Course No:	se No: 23 Course Name: Coding Theory Course Code: MMAE 0024									
Batch:		Programme: M.Sc.	Semester:	L	Т	Р	J	Credits	Contact Hrs Per Week:4	
2024-2026		Mathematics	II/III/IV	4	0	0	0	4	Total Hours: 4	0
Total Evalua	ation 1	Marks: 100	Examinatio	on Du	iratio	n: Mid	Term	(2 hours), H	End Term (3 hou	rs)
Theory Asso Internal Ass	essme sessm	ent: 75 Marks ent: 25 Marks	Pre-requisi	te of	cours	se: Abst	ract A	lgebra		
Course	This	course will dev	elop a profo	und ı	inders	tanding	of lin	ear codes, e	ncoding and dec	oding of
Objective	linear	codes and their	r applications	s. Fur	ther, a	deep u	ndersta	anding of cy	clic, BCH and qu	aternary
	linear	codes, and th	eir advantag	es in	findir	ng the s	solutio	n of mather	natical problems	will be
	devel with a	oped in this co all CO's.	urse. This co	ourse	focus	es on e	nploya	ability and s	skill development	aligned
	After	studying these	topics, the st	ıdent	s will	be able	to:			
Course	<b>CO1</b> :	Calculate the	parameters o	f give	en cod	les and	their c	lual codes u	ising standard ma	trix and
Outcomog	~ ~ •	polynomial op	perations.		_		_			
Outcomes	CO2	codes.	decode infor	matic	on by	applyir	ng algo	orithms asso	ociated with wel	l-known
	CO3	State and prove	e the fundam	ental	theore	ems abo	ut erro	r-correcting	codes.	
	CO4	Compare the	error-detect	ing/c	orrecti	ng faci	lities	of given co	odes for a giver	ı binary
		symmetric cha	annel.							
	<b>CO5</b>	Design simple	linear or cyc	lic co	des w	ith requ	ired pr	operties.		
	<b>CO6</b>	: Solve mather	matical prob	lems	invol	ving e	rror-co	rrecting co	des by linking	them to
		concepts fror	n elementary	num	ber the	eory, co	ombina	torics, linea	r algebra, and ele	ementary
		calculus.	COI	IRSI	SVI	LARI	S			
Module No.					Cont	ent	0			Hours
	[Cou	rse Autcome(s	$\mathbf{N}_{0} \cdot 1$ and	<b>7</b> 1						
	Line	ar Codes Brie	f introductio	n to	coding	^o theor	z Line	ear codes. F	Jamming weight	
	Hami	ming code Ba	ses for lines	r coo	les G	enerato	r mati	iv and Par	ity_check_matrix	
т	Equiv	valence of lines	r codes En	n cot	a with	o lino	ar cod	a Dacadina	ty check matrix,	20
-	Case		h coues, En	Jouin	g with . 1:			e, Decouilig	, or intear coues,	20
	Cosei	is, Nearest neig	ndor decodi	1g 101	rinea	r codes	, Syna	rome decod	ling, Golay code,	
	Reed	-Solomon code.								
	[Cou	rse Outcome(s	s) No.: 3, 4,	5 and	l 6]					
	Cycli	c codes: Defini	tion of cyclic	c cod	es, Ge	nerator	polyno	omials, Gen	erator and parity-	
	check	matrices, Dec	oding of cy	clic c	odes,	Burst-e	rror-co	orrecting co	des, BCH codes,	•
II	Paran	neters of BCH	codes, Decod	ling o	of BCl	H codes	s, Quat	ernary linea	r codes and their	. 20
	gener	ator matrices.		U				2		
Text Books										1
$\succ$ S Li	ng & (	Xing Coding	Theory A F	First (	ourse	Cambr	idge U	niversity Pre	ess 2004	
$\rightarrow$ D R	Hank	rerson D G H	offman D A	Leo	nard	CCI	indnei	· K T Phe	Ins C A Rodger	· & I R
Wall,	, Codi	ng Theory and C	Cryptography	: The	Esser	tials, C	RC Pr	ess, 2000.	ips, C. A. Rouger	α J. Κ.
Reference B	ooks:									
≻_Z. X.	Wan	: Quaternary co	des, World S	cienti	fic, Pı	ıblishin	g Com	pany Pvt. Li	td., 1997.	
۱ <u>ــــــــــــــــــــــــــــــــــــ</u>										

Course No: 2	Course No: 24Course Name: CryptographyCourse Code: MMAE 0025								
Batch:	Programme: M.Sc.	Semester:	L	Т	Р	J	Credits	Contact Hrs Per Week:4	
2024-2026	Mathematics	II/III/IV	4	0	0	0	4	Total Hours: 4	0
Total Evalua	tion Marks: 100	Examinatio	on Du	iratio	n: Mid	Term	(2 hours), I	End Term (3 hour	rs)
Theory Asse Internal Ass	essment: 75 Marks sessment: 25 Marks	Pre-requisi	ite of	cours	e: Abst	ract A	lgebra		
Course	This course will de	velop a prof	ound	under	standin	g of c	ongruences	, primitive roots,	various
Objective	types of numbers, Fe	ermat's last t	heore	m and	their a	pplicat	ions. The st	tudents will also l	earn the
	concept of cryptogr	aphy, Caesai tography T	r Cip his c	her, D ourse	iffie-He	ellman	RSA publ	ic key cryptosyst v and skill deve	tem and
	aligned with all CO's	S.	•	ouise	10000000	011 0	mpiojuomi	j und shin deve	iopinein
	After studying these	topics, the stu	udent	s will	be able	to:			
G	CO1: Understand co	ngruences, p	rimiti	ve roo	ts and t	heir ap	plications.		
Course	CO2: Use the basics	of RSA secu	rity a	nd be	able to	break t	the simplest	instances and ana	alyze the
Outcomes	basic concepts	s of remote co	oin fli	pping,	elliptic	curve	based crypt	tography.	
	<b>CO3:</b> Apply the theo	orems: Ferma	t's la	st theo	rem, pri	ime nu	mber theore	m and zeta functi	on.
	CO4: Understand an	d use the nur	nbers	: perte	ct num	pers, F	ermat numb	ers, Mersenne pri	mes and
	amicable num	bers, Fibonad		mbers	T A DIT	G			
		COL	JK21	LSIL	LABU	3			-
Module No.				Cont	ent				Hours
	[Course Outcome(s	) No.: 1 and	2]						
	Modular arithmetic,	Congruence	, Prii	nitive	roots,	Crypto	ography inti	oduction, Caesar	
	Cipher, Diffie-Helli	man RSA j	public	e key	crypto	osyster	n, Knapsao	ck cryptosystem,	20
I	Application of prin	nitive roots	to c	ryptog	raphy,	Appli	cations of	cryptography in	20
	primality testing and	l factorizatio	n of	large o	composi	ite nur	nbers, Rem	ote coin flipping,	
	Elliptic curve based	cryptography	•						
	[Course Outcome(	s) No.: 3 and	d 4]						
	Perfect numbers, Fer	rmat numbers	s, Me	rsenne	primes	and A	Amicable nu	mbers, Fibonacci	
	numbers, Represent	ation of in	tegers	s as s	sum of	squa	res, Linear	and non-linear	
II	Diophantine equation	ns, Fermat's l	last th	eorem	, Prime	numb	er theorem a	and Zeta function.	20
Text Books:									1
≻ H.C.	A. Tilborg, Fundame	entals of Cryp	otolog	y, Spr	inger, 2	013.			
≻ J. A. ]	Buchmann, Introduct	ion to Crypto	logy,	Spring	ger Scie	nce &	Business M	ledia, 2012.	
> D. M.	Burton, Elementary	Number The	ory, 7	Tata M	cGraw	Hill Pu	ublishing Ho	ouse, 2006.	
➤ A. J.	Menezes, P. C. V.	Oorschot and	1 S. A	A. Var	stone,	Handb	ook of App	olied Cryptograph	iy, CRC
Press,	, 1996.		-		~ ~ •				
▶ D. R.	Hankerson, D. G. H	ottman, D. A	A. Leo	onard,	C. C. L	andner	, K. T. Phe	Ips, C. A. Rodger	& J. R
Wall,	Coding Theory and (	Cryptography	: The	Essen	tials, C	RC Pr	ess, 2000.		
Reference P	ooks.								

- Ference Books:
  N. Koblitz, A Course in Number Theory and Cryptography, Springer, 1994.
  G. J. Simmons, Contemporary Cryptology, The Science of Information Integrity, IEEE Press, 1992.

Course No: 2	<b>Course Name:</b> Wavelet Analysis <b>Course Code:</b> MMAE 0026											
Batch:	Programme: M.Sc.	Semester:	L	T	Р	J	Credits	<b>Contact Hrs</b> <b>Per Week:</b> 4				
2024-2026	Mathematics	II/III/IV	4	0	0	0	4	<b>Total Hours:</b> 40	)			
Total Evalua	ntion Marks: 100	Examinatio	on Di	uratio	n: Mid	Term	(2 hours), I	End Term (3 hour	rs)			
Theory Asse Internal Ass	essment: 75 Marks sessment: 25 Marks	Pre-requis	ite of	cours	se: Nil							
Course	The course aim is	to introduce	a fl	exible	system	whic	h provide s	stable reconstruct	ion and			
Objective	analysis of function operators on a single	s (signals) and e wavelet fund	d the ction.	constr	ruction of	of varie	ety of ortho	normal bases by a	pplying			
	After studying these	topics, the st	udent	s will	be able	to:						
	<b>CO1:</b> Understand the approximation of functions (signals) by frame theory.											
Course	<b>CO2:</b> Use the applications of frames in stable analysis and decompositions of functions											
Outcomes	<b>CO2:</b> Use the applications of frames in stable analysis and decompositions of functions.											
	<b>CO3:</b> Learn the applications of wavelets in the construction of orthonormal bases by wavele											
	<b>CO4:</b> Analyze diffe	erent types of	trans	forms	in terms	s of ope	erators.					
	COURSE SYLLABUS											
Module No.				Cont	tent				Hours			
	[Course Outcome(s	s) No.: 1 and	2]									
	Orthonormal system	ns, frames in (	C ⁿ , fr	ames	algorith	ms, fra	mes and Be	essel sequences in				
	infinite dimensiona	l Hilbert spa	ices,	frame	sequer	nce, G	ram matrix	associated with				
Ι	Bessel sequences. F frames. Riesz bases	Frames and op frames conta	perato ining	ors, ch a Ries	aracteri: sz basis,	zation , pertur	of frames, or bation of frames, or the second secon	dual frames, tight ames.	20			
	[Course Outcome	(s) No.: 3 and	d 4]									
	Wavelets: Introduc	tion. Haar wa	avelet	ts. pro	perties	of the	Haar scalir	ng function. Haar				
	decomposition and	reconstruction	n algo	orithm	s. the D	aubech	nies wavele	ts. wavelet bases.				
Π	scaling function. mu	ltire solution	analy	vsis (N	IRA), c	onstruc	ction of way	velets from MRA.	20			
	Windowed Fourier	transform, co	ontinu	ious F	ourier a	and wa	velet transf	orms. continuous				
	wavelet transform a	s an operator,	inver	sion fo	ormula	for con	tinuous way	elet transform.				
Text Books:		1 /										
A. Bo amp;	oggess, and F. J. Naro Sons, 2010.	cowich, A Fir	st Co	urse in	Wavel	ets and	Fourier An	alysis. John Wiley	y &			
$\succ$ S. Ma	allat, A Wavelet Tou	r of Signal Pro	ocessi	ing, A	cademic	Press.	2009.					
D. Ha 2007.	an, K. Kornelson, D.	Larson and E	. Weł	ber, Fr	ames fo	r Unde	ergraduates,	Student Math. Lil	D.,			
Reference B	ooks:	. –		151				_				

- O. Christensen, An Introduction to Frames and Riesz Bases, Birkhauser, 2003.
   E. Harnendez, and G. Weiss, A First Course on Wavelets, CRC Press, 1996.

Course No:	<b>No:</b> 26 <b>Course Name:</b> Information Theory <b>Course Code:</b> MMAE 0027									
Batch:		Programme: M.Sc.	Semester:	L	Т	Р	J	Credits	Contact Hrs Per Week:4	
2024-2026		Mathematics	II/III/IV	3	1	0	0	4	<b>Total Hours:</b>	
Total Evalu	ation I	Marks: 100	Examinatio	on Di	iratio	n: Mid	Term	(2 hours), H	End Term (3 hour	rs)
Theory Ass Internal As	essme sessm	nt: 75 Marks ent: 25 Marks	Pre-requisi	ite of	cours	se: Nil				
Course Objective	The o cours their a	bjective of this e further explain applications.	course is to i ns different t	ntrod ypes	uce ba of ent	usic and ropies, o	advan codes,	ced topics in discrete and	n information theo continuous chan	ory. This nels and
Course Outcomes	After CO1: CO2: CO3: CO4:	studying these Understand th their propertie Analyze how Understand at Know about c	topics, the stree e basic conce s and applica different codi bout discrete continuous ch	udent epts o utions ng teo chann annel	s will f infor chniqu els and s and	be able mation es will p l their pr their pro	to: theory perform copertie	, different ty in different es with applie s with applie	ypes of entropies v situations. cations. cations.	with
Madula Na	COURSE SYLLABUS									Houng
I II	[Course of the second s	rse Outcome(s) oure of uncerta py, conditional py due to Shanr herable codes, i rse Outcome(s rse outcome(s sed by a chan ver, the fundar erses. inuous channel solutely continue ed channels.	No.: 1 and inty: Introd entropy, tran ion and Fade instantaneous b) No.: 3 and ess channel: nel, calculat nental theor is: Introduction ious random	2] luctio sform eev. I code 1 4] Intro ion c em c ion, th varia	n, axion, ngredi s, opti oduction of chan of info ne time ble, th	oms, pr axioma ents of mal coc on, clas nnel cap ormation e-discre e time-(	opertie atic cha noisele les and sification pacity, n theorete continu	es of Shann aracterizatio ess coding p I their constr ion of chan decoding s ry and its s ussian chann ious Gaussia	on entropy, joint n of the Shannon problem, uniquely ruction. nels, information chemes the ideal strong and weak el, uncertainty of an channel, band-	20
Pext Books: → R. B → F. M Reference E → H. D Com → J. Ac New	. Ash, ] . Reza, <b>Gooks:</b> . Hank pressic zel and York.	Information The An Introductio erson, G. A. Ha on, CRC, 2003. d Z. Daroczy, O 1975.	eory, Courier n to Informa rris and P. D n Measures o	Corp tion 7 . John of Inf	ooratio Theory nson, l ormati	n, 2012 , Courie Introduc	er Corp etion to their C	ooration, 20 Information	12. n Theory and Data ions, Academic P	a Press,

# **SYLLABI OF SUBJECTS**

# **DISCIPLINE SPECIFIC ELECTIVE COURSES (DSE)**

# **BOUQUET 2**: DATA SCIENCE

Course No:	<b>b:</b> 1 <b>Course Name:</b> Probability theory and Distributions <b>Course Code:</b> MMAE 0101													
Batch:	Programme:	e: Semester: L T P J Credits Contact Hrs Sc Per Week:4												
2024-2026	M.Sc. Mathematics	П	1	0	0	1		4	Per V	vveek:4	IN			
Total Evalue	tion Marke. 100		_ <del>+</del>			Ľ		+		1				
	<b>IIIUII IVIAI KS;</b> 100	Examination Dur	atio	n: Mid	Ter	rn	n (2	hours	s), En	d Term (3	hours)			
Theory Asse	essment: 75 Marks	Pre-requisite of c	01115	e: Nil										
Course	This course will develop	a profound underst	andir	$\frac{1}{10} \text{ of } \mathbf{n}$	roha	ah	vility	laws	prob	ability dist	ributions			
Objective	and their applications T	his course will ma	ke ti	ie stud	ents	3	ahle	to cs	, proo alculat	te exnectat	ions and			
JULUIT	generating functions Fun	ther, a deep under	standi	ing of	sam	nl	lino	distri	hutior	is for the t	esting of			
	hypothesis will be deve	loped in this cours	e. Tł	nis cou	rse	יץ f	ocus	ses on	emn	lovability	and skill			
	development aligned with	n all CO's.	11						p		Skill			
	After studying these topic	cs, the students will	be al	ole to:										
	<b>CO1:</b> Apply techniques t	o solve day to day r	proble	ems rel	ated	1 t	to pr	obabi	lity.					
G	<b>CO2:</b> Calculate different	types of expectatio	n and	l use di	ffere	er	nt in	equali	ties ir	n statistics.				
Course	CO3: Compute different	types of generating	func	tions.			_	1						
Outcomes	<b>CO4:</b> Understand different probability distributions and their uses in real life problems.													
	CO5: Understand sampling distributions and use it for hypothesis testing.													
	CO6: Apply order statistics, lay exploiting and their properties, particularly													
	their distributions.						-							
	ı	COURSE SYI	LLA	BUS										
Module No.		Con	tent								Hours			
	[Course Outcome(s) N	o.: 1, 2 and 3]						<b>.</b>						
	Probability and Rande	om Variables: Ra	ndon	ı expe	rime	en	its,	Empi	rical j	probability	,			
т	Algebra of events, Laws	ot probability, Con	nditio	nal pro	obat	oil	lity,	Indep	ender	nce, Bayes	໌ 			
	Law, One-dimensional	random variable,	Disti	ribution	ı fu	JN	nctio	n and	d its	properties	20			
	Bivariate random variat	oles and their distr	ibutio	ons (jo	ınt,	n	marg	ginal a	and co	onditional)	,			
	Functions of random vari	adies, Transformati	on te	cnniqu Vori	e.		C			Condition	1			
	expectation Markov II.	ation: Expectatio	ll, abral	varian	ce,	10	U0V		e, (	conditiona	.1			
	of large numbers Kalma	arov's theorem C	euysi	10 V S II   limit +	hea	id ro	unty, em	vv Cal	anu :	suong law	5			
	Concreting Functions	Probability concre	tion	functi		'n 'n	un.	) Ma	mont	ganaratin	n			
	function (m g f) Charact	eristic function	uuui	runcu(	л (	ι. Γ	.g.1.	<i>)</i> , 1 <b>V</b> 10	ment	generating	5			
	Course Outcome(s) N	$0 \cdot 1 5 \mathbf{and} 6$												
	Discrete Distributions	Remoulli Rinomi	al P	nicenn	G	er	omet	tric L	Ivner	geometric				
	Negative Binomial and $\Gamma$	Discrete Uniform dis	trihu	tions	, 00			, 1	Typer	Sconicult	´ >			
II	Continuous Distribution	ns: Normal. Unifor	m. F.	xponer	ntial	. (	Gan	ıma l	Beta (	Type I and	d 20			
	Type II), Cauchy, We	ibull, Lognormal.	Logi	istic. 1	Lapl	, la	ice.	Paret	o and	d Rayleig	n			
	distributions. Concept of	truncated distribution	ons.	,	-r-		,			,				
	Sampling Distributions	: Sampling distribu	tion	of mea	n. F	Fir	nite	popul	ations	s, Samplin	g			
distribution of proportion, Finite populations, Distribution of sample variance, Chi-										-				
	square distribution, t and	F distributions, Ord	ler sta	atistic.				1		·				
Text Books:	<u> </u>													
> P. Mu	khopadhyay, An Introduc	ction to the Theory	of Pro	obabilit	ty, V	No	orld	Scien	tific, 2	2012.				
▶ P. L. ]	Meyer, Introductory Prob	ability and Statistic	al Ap	plication	ons,	С	Oxfo	rd and	I IBH	Publishers	s, 1970.			
Reference Bo	ook:													
➢ V. K.	Rohtagi & A. K. Md. Eh	sanes Saleh, An Inti	oduc	tion to	Pro	ba	abili	ty and	l Stati	stics, John	Wiley			
& Soi	ns, 2015.													

Course No: 2	2 <b>Course Name:</b> F	Regression An Predictive Me	nalysi odelli	s and ng	Cours	se Cod	e: MMAE (	0102		
Batch:	Programme: M.Sc.	Semester:	L	Т	Р	J	Credits	Contact Hrs Per Week:4		
2024-2026	Mathematics	II	4	0	0	0	4	Total Hours: 4	0	
Total Evalua	tion Marks: 100	Examinatio	on Di	uratio	n: Mid	Term	(2 hours), l	End Term (3 hou	rs)	
Theory Asse Internal Ass	essment: 75 Marks sessment: 25 Marks	Pre-requisi	ite of	cours	e: N	Jil				
Course	This course will dev	elop a profo	und	unders	tanding	of no	rmed linear	spaces. This cou	ırse also	
Objective	includes bounded, u	inbounded and	nd cl	osed o	operator	s. orth	nonormal b	asis and their pr	operties.	
	Further a deep unde	erstanding of	stand	lard th	eorems	and th	eir applicat	ions will be deve	loped in	
	this course. This cour	rse focuses of	n emi	nlovahi	lity and	l skill i	develonmen	t aligned with all	CO's	
	A ft an atta daring a the age			:11 1		4	ue ve lopinen		00 3.	
	CO1: Understand the CO2: Apply and use CO3: Understand the	e concept of e Gauss-Mark he Difference	estim ov th e bet	ation o eorem	f param to obta R-Squa	neters i in best red an	n regressior linear unbia d Adjusted	n model. ased estimates. R-Squared and	interpret	
	them as a mea	sure of good	ness o	of fit.						
Course	CO4: Apply tests f	for linear hy	photh	nesis to	esting	to dete	ermine the	relationship betw	veen the	
Outcomes	response and predictor variables.									
	CO5: Learn and app	ly methods ic	or mo		equacy	cnecki	ng. Sabadanta	d when the up	darluina	
	coo: Understand	f multiple lin		os and	u ine	approa	ach adopte	a when the un	derlying	
	assumptions of CO7. Understand t	he type of 1	lear re	egressi	on moo	proson	b. t in the m	odal and apply	mathods	
	accordingly	ne type of t		JSCCUA	sticity	presen		ouch and apply	memous	
	CO8: Understand the	e problem of	multi	colline	earity an	nd how	to deal wit	h it.		
		COU	URSI	E SYL	LABU	S				
Module No.				Cont	ent				Hours	
	[Course Outcome(s	s) No.: 1, 2, 3	3 and	4]						
	Multiple linear regre	ession model	and a	assum	otions,	estimat	tion of para	meters, estimable		
	functions, error and e	estimation spa	ace, C	Gauss-I	Markov	theore	em, use of g	-inverse.		
Ι	Model in deviation	form, ANOV	'A fo	r linea	r mode	$l, R^2,$	adjusted $R^2$	and other model	20	
	selection criterion, te	sts of linear l	iypot	hesis, f	forecast	ing.	5			
	Model Adequacy C	hecking: ch	eckin	g of 1	inear i	relation	nship, resid	ual analysis and		
	scaling of residuals,	, regression	varia	ble hu	ll, PRF	ESS re	siduals, R-	student residuals,	,	
	residual plots, partia	l residual plo	ts, de	etectior	n and tr	eatmer	nt of outlier	s, Diagnostics for	•	
	leverage and influence	ce, measures	of inf	luence						
	[Course Outcome(s	s) No.: 5, 6,	7, an	d 8]						
	Estimation of parame	eters by gene	ralize	ed least	t square	es (GL	S) in linear	models with non-	-	
	spherical disturbance	es, Gauss M	arkov	v theor	em for	GLS	estimator,	estimation under	-	
II	heteroscedasticity ar	nd tests of h	eteros	scedast	icity, t	ests fo	r autocorre	lation, estimation	20	
	and forecasting unde	r autocorrelat	ted di	sturba	nces.					
	Generalized Linear	Models: Log	istic 1	Regres	sion, P	oisson	Regression	and Generalized		
	Linear model.									
	Multicollinearity: Int	troduction, so	ources	s of m	ılticolli	nearity	, effects of	multicollinearity,	,	
	variance Inflation f	actors (VIF)	, Me	thods	of dea	ling w	with multico	ollinearity, Ridge	¢	
	kegression.									
	1								1	

- N. R. Draper & H. Smith, Applied Regression Analysis, Wiley, 1998.
- > J. Johnston, Econometric Methods, McGraw Hill, 1984.
- D. C. Montgomery, E. A. Peck & G. G. Vining, Introduction to Linear Regression Analysis, Wiley, 2006.

- C. R. Rao, H. Toutenburg, Shalabh, C. Heumann & M. Schomaker, Linear Models and Generalizations-Least squares and Alternatives, Springer, 2007.
- ▶ J. F. Monahan, A Primer on Linear Models, CRC Press, 2008.
- > A. I. Khuri, Linear Model Methodology, CRC Press, 2010.
- ▶ G. A. F. Seber, & A. J. Lee, Linear Regression Analysis, Wiley, 2003.

Course No: 3	<b>Course Name:</b> Time S	eries Analysis And Fo	oreca	sting	Cou	rse	Code: M	MAE 0103					
Batch:	Programme: M.Sc.	Semester:     L     T     P     J     Credits     Contact Hrs       Per Week:4											
2024-2026	Mathematics	III	3	0	2	0	4	Total Hours: 4	0				
Total Evalua	tion Marks: 100	Examination Du	atio	n: Mi	d Te	rm (2	2 hours),	End Term (3 ho	ours)				
Theory Asse Internal Ass	ssment: 75 Marks essment: 25 Marks	Pre-requisite of c	ours	e:	Nil								
Course Objective	This course will develop techniques. The students Further, a deep understar analysis will be developed aligned with all CO's.	a profound understa will learn various n ding of ARCH and in this course. This c	nding Iodel GAI	g of t s for RCH e focu	ime-s statio mode ses o	series onary els c n en	s, its con y and no of heteros pployabili	nponents and smon-stationary timescedasticity and ty and skill deve	noothing e-series. spectral lopment				
Course Outcomes	<ul> <li>After studying these topics</li> <li>CO1: Understand the compexpose its important</li> <li>CO2: Visualize time sericovariances, acf and</li> <li>CO3: Understand the comproblems.</li> <li>CO4: Estimate the statistic</li> <li>CO5: Analyze and forecas</li> <li>CO6: Understand the application</li> </ul>	<ul> <li>1: Understand the components of time series and apply smoothing techniques to the data and better expose its important patterns.</li> <li>2: Visualize time series as a stochastic process and be able to obtain the means, variances, covariances, acf and pacf to understand the behavior of time series data.</li> <li>3: Understand the concept of stationarity and non-stationarity and apply the methods in real-time problems.</li> <li>4: Estimate the statistical models and forecast them.</li> <li>5: Analyze and forecast volatality with the help of ARCH and GARCH models.</li> <li>6: Understand the application of frequency-domain time-series analysis.</li> </ul>											
		COURSE SYL	LAF	BUS									
Module No.		Cont	ent						Hours				
I	[Course Outcome(s) No. Components of Time-Ser methods of estimation- Tr single and double exponen Fundamental Concepts: function (acvf) and autoco (pacf), correlosram, lag op and invertibility conditions Models for Stationary	<b>: 1, 2 and 3]</b> <b>ries and Smoothing</b> end, Seasonal, Movi- tial smoothing, Helt-V Time Series and Si prrelation function (a perators and Linear fi <b>Fime Series:</b> Estima	<b>Tech</b> ng A Vinte tocha acf) a lters,	nique verag rs me sting t lag Ergo and	es: C es: S thod. Proc k, P dicity forec	lassic impl cess, artia artia astin	cal decom e, Centre Sample l autocor l Stationa g, Wold	nposition model, and weighted, auto covariance relation function rity, Stationarity Decomposition	20				
	general linear process and its acvf, acf, Auto Regressive (AR) process, Moving Average (MA) process, acf and pacf of AR and MA processes, Yule-walker equations for AR processes, nixed ARMA process. ARIMA (p,d,q) model, estimation of parameters, identification of processes with ACF, PACF, Model order estimation and forecasting.												
II	[Course Outcome(s) No. Non-Stationary Processe Dickey fuller, augmented I Time Series Models of He Spectral Analysis:Freque density function of statio spectral distribution functio	<b>: 3, 4, 5 and 6]</b> <b>s:</b> Forms of non-stat Dickey-Fuller and Phi <b>eteroscedasticity:</b> AR ncy domain analysis nary linear processes on, estimation of spec	ionar llips- CH a -spec s, cro tral d	ity in perror and G. tral d pss-sp ensity	time n test ARC lensit ectru	e ser s for H Pr y an m fo ction,	ies, rando unit root, ocesses. d its pro or multiv periodog	om walk model perties, Spectral ariate processes gram analysis.	20				

- G. E. P. Box, G. M. Jenkins, G. C. Reinsel & G. M. Ljung, Time Series Analysis, Forecasting and Control, Wiley, 2015.
- > P. J. Brockwell & R. A. Davis, Time Series: Theory and Methods, Springer, 2009.

- ▶ G. Kirchgässner & J. Wolters, Introduction to Modern Time Series Analysis, Springer, 2007.
- C. W. J. Granger & M. Hatanaka, Spectral analysis of economic time series. (PSME-1), Princeton University Press, 2015.
- D. C. Montgomery, L. A. Johnson & J. S. Gardiner, Forecasting and Time Series Analysis, McGraw-Hill Companies, 1990.
- M. B. Priestley, Spectral Analysis and Time Series: Probability and Mathematical Statistics, 1981.

Course No: 4	No: 4 Course Name: Database Management System Course Code: MCAC 0009											
Batch:		Programme:	J	Credits Contact Hrs								
		M.Sc.						Per Week:4				
2024-2026		Mathematics	III/IV	3	0	0	0	3 <b>Total Hours: 4</b>	0			
Total Evalua	tion N	<b>/larks:</b> 100	Examinatio	on Du	ration: Mid	Tern	n (2 ł	nours), End Term (3 hour	rs)			
Theory Asse	essme	<b>nt</b> : 75 Marks	Pre-requisi	te of c	ourse Nil							
Internal Ass	sessmo	ent: 25 Marks	i i c-i cquisi									
Course	To ac	quire the know	ledge of data	base d	esign, data n	nodel	s and	d database languages and	to study			
Objective	the p	hysical and lo	gical databa	se des	igns, databa	se m	odel	ing, relational, hierarchi	cal, and			
	netwo CO's.	ork models. Thi	s course foc	uses of	n employabi	lity a	nd sl	kill development aligned	with all			
	After	studying these	topics, the stu	ıdents	will be able	to:						
Course	CO1:	Understand the	e basic conce	pts and	I the applicat	ions	of da	tabase systems.				
Outcomos	<b>CO2</b> :	Design ER Mo	del and Rela	tional	Database Sch	nema	for r	eal world application, give	en			
Outcomes	cor.	unambiguous p	broblem state	ment.	1. (	1.1.	1 .	1 1 1				
	CO3:	Implement SQ	L queries to a	access	uata, given r			and functions for a si	von			
	CU4:	scenario	ws, constrain	is and 1	nuex, PL/SQ	L pro	sceat	mes and functions for a gr	ven			
	C05.	Develop relativ	nal alcebra 4	aynraci	sions given t	he re	latio	nal datahase schema				
	CO6:	Understand an	d apply datab	ase no	rmalization	orinci	ples	nai database senema.				
	CO7:	<b>CO7:</b> Describe the concepts of transaction and classification of database.										
	COURSE SYLLABUS											
Module No.					Content				Hours			
	[Cour	rse Outcome(s)	No.: 1, 2, 3,	5 and	6]							
	Intro	duction: An C	verview of	Databa	ise Managen	nent	Syste	em, Database System Vs				
	File S	System, Databa	ise System (	Concep	ot and Arch	itectu	re, I	Data Model Schema and				
I	Instan	ces, Data Inde	pendence, Da	atabase	e Language a	and Ii	nterfa	aces (DDL, DML, DCL),	20			
	Datab	ase Developme	nt Life Cycle	e (DDL	C) with Cas	e Stu	dies.					
	Data	Modeling Usir	ng the Entity	v-Rela	tionship Mo	del:	ER N	Aodel Concepts. Notation				
	for I	ER Diagram.	Mapping	Constr	aints. Kevs	. Sr	becia [†]	lization. Generalization.				
	Agore	egation Reducti	ion of an ER	Diaors	um to Tables	, ~r Exte	nded	FR Model				
	Relat	ional Data M	odel and La	monac	e Relation	al Da	ta M	Indel Concepts Integrity				
	Const	roints Entity	Integrity	Dofore	ntial Integr	u Da	Kov	Constraints Domain				
	Const	raints, Ellury	al Algobro	NUICIE	mia megi	ny,	ксу	s Constraints, Domain				
	Detal	namus, relation	ai Aigeola.	on L.	Functional D	oner	lona	on Drimowy Vor Forsi-				
		Condidate V	Super V-		runctional D	epeno	Jenci Zaaz	es, Filling Ney, Foreign				
	rey,	Canulate Key	, Super Key,	inorm	iai rorms, F	irst, S	secoi	na, i nira normai forms,				
	BCN	, Non-Redunda	ant Cover, Ca	inonica	al Cover.							
		rse Outcome(s	s) No.: 3, 4, (	6 and	7] 44 No. 1	Б	5.1					
		base Design &	Normalizat	$D_{\alpha}$ In	4th Normal	Forr	n, 5u	n Normal Form, Lossiess				
тт	File Organization: Indexing Structure of Index files and types Danse and Sparse											
11	Indexing.											
	Trans	saction Proces	ssing Conce	pt: T	ransaction S	vster	n. T	esting of Serializability.				
	Serial	izability of Sc	hedules, Cor	flict d	& View Ser	ializa	ble S	Schedule, Recoverability.				
	Recov	very from Trans	action Failur	es, Log	g Based Reco	overy	, Dea	dlock Handling.				
	Conc	urrency Cont	rol Techniq	ues: (	Concurrency	Cont	rol,	Locking Techniques for	•			
	Concu	urrency Contro	ol, 2PL, Ti	me St	amping Pro	tocol	s fo	r Concurrency Control,				
	Valid	ation Based Pro	tocol.									
	Distributed Database: Introduction of Distributed Database, Data Fragmentation and											
	Replic	cation.										

R. Elmasri & S. B. Navathe, Fundamentals of Database Systems, Pearson, 2010.

- > C. J. Date, An Introduction to Database Systems, Pearson, 1999.
- A. Silberschatz, H. Korth, S. Sudarshan, Database Systems Concepts, McGraw-Hill Education, 2005.
- B. C. Desai, An Introduction to Database Systems, Gagotia Publications, 2010.
- A. Majumdar & P. Bhattacharya, Database Management System, McGraw Hill Education, 2017.

Course No: :	5	CourseName: Databas	se Management Sys	tem La	b	Cou	rse	Code: N	ACAC 08	07
Batch:		Programme: M.Sc.	Semester:	L	T	Р	J	Credits	Contact Per We	Hrs ek:2
2024-2026		Mathematics	III / IV	0	0	2	0	1	Total Ho	ours:20
Total Evalua	tion 1	Marks: 100	Examination 1	Duratio	on: E	and T	ern	n (2 hour	s)	
Internal: 50 External: 40 Attendance:	Mark ) Mar 10 N	ts ks Iarks	Pre-requisite	of cour	se: N	Vil				
Course Objective	To in focus	nplement the concept of es on employability and	f entity relationship skill development	approa aligned	ich ai with	nd da all C	atab O's	ase langı	uages. Thi	s course
Course Outcomes	After CO1 CO2 CO3	studying these topics, th Apply SQL queries for Develop the SQL queries Implement the procedu	ne students will be a DML and DDL. ies for real life scen iral language (PL/S) COURSE SYLLA	ible to: arios. QL) and A <b>BUS</b>	l Trig	gers.				
Module No.			Content							Hours
I / II Text Books:	Image: Intervention of the second of the									20
<ul> <li>R. Eli</li> <li>P. Sac</li> <li>Persis</li> </ul>	masri dalage stence <b>Books</b>	& S. B. Navathe, Funda e, & M. Fowler, NoSQL , Addison Wesley, 2012	mentals of Database Distilled: A Brief C	e Syster Guide to	ns, Po the l	earso Emer	on, 2 ging	2010. g World (	of Polyglo	ıt
≻ C. J.	Date,	An Introduction to Data	base Systems, Pears	on, 199	9.					

- A. Silberschatz, H. Korth & S. Sudarshan, Database Systems Concepts, McGraw-Hill Education, 2010.
- E. Redmond & J. R. Wilson, Seven Databases in Seven Weeks: A Guide to Modern Databases and the NoSQL Movement, O'Reilly, 2012.

Course No: (	6	Course Name: Machine Learning for Data Science Course Code: MMAE 0104									
Batch:		Programme: M.Sc.	Semester:	L	Т	Р	J	Credits	Contact Per We	Hrs ek: 4	
2024-2026		Mathematics	III/IV	3	0	2	0	4	Total Ho	ours: 40	
Total Evalua	tion I	Marks: 100	Examination Duration: Mid Term (2 hours), End Term (3 hours)								
Theory Asse Internal Ass	essme Sessm	ent: 75 Marks ent: 25 Marks	<b>Pre-requisite of course:</b> Regression Analysis and Predictive Modelling: Multivariate Analysis								
Course	This	course will develop	a profound understand	ling of	diffe	erent	clust	tering alg	orithms a	and their	
Objective	applications to real-life problems. This course includes various methods to produce one predictive model. Further, a deep understanding of cross-validation techniques for appli for algorithms will be developed in this course. This course focuses on employability a development aligned with all CO's.								e optical licability and skill		
	After	studying these topics	s, the students will be a	ble to:							
Course	CO1:	: Understand the cond	cept of Machine Learni	ing of i	dent	ify th	e tec	hniques s	suitable fo	or real-	
Outcomes		life data problems.		-							
	CO2:	: Know and apply dif	ferent clustering algori	thms to	o rea	l-life	prob	olems.			
	CO3: Deal with missing data, classify unseen data.										
	<b>CO4:</b> Learn methods to produce one optical predictive model.										
	COURSE SVILAPUS										
Madula No	Τ		Content							Uoure	
	10									nours	
Ι	The basic concept of machine learning, types of machine learning: supervised and unsupervised. Associations, Classification Trees and Regression Trees, Probably Approximately Correct Learning (PAC), Support Vector Machines. Nearest Neighbor Methods, Validation: Nearest neighbor prediction, K-nearest neighbor methods, Weighted neighbor methods, Kernel density estimation. Bayesian Classifiers and Error Rates. Linear Discrimination: Generalizing the Linear Model, Pairwise Separation, Gradient								20 t		
		arce Outcome(s) No	$\cdot 2  4 \text{ and } 51$								
<ul> <li>Clustering: Introduction, Similarity measures, Ward's Hierarchical Clustering, N</li> <li>hierarchical clustering, K-Means Clustering, choosing the number of clusters. Mi</li> <li>of Latent Variable Models.</li> <li>Multivariate Data: Parameter Estimation, Estimation of Missing Values, Gaussi</li> </ul>						, Non- Mixtures ssian	20				
	mixures, Expectation-Maximization (EM) algorithm, Multivariate Classification, Tuning Complexity, Discrete Features. <b>Support vector machines</b> (SVM): linear SVM, Lagrangian optimization and duality, kernel trick, VC dimension. <b>Ensemble Methods</b> : Stacking, Bagging and Boosting.										
Text Books:	·									4	
$\rightarrow$ H. Da	umé,	A course in Machine	e Learning, Alanna Mal	donado	), 202 ·	23.			11.		
➢ K. S.	Micha	alski, J. G. Carbonell	& T. M. Mitchell, Machine learning: An Artificial Intelligence								
Appro	bacn,	Morgan Kaufmann Pu	iblishers, 1984.								
Reference Bo ≻ A. Ett ≻ P. Da	o <b>oks:</b> hem, I ngeti,	Introduction to Mach Statistics for Machiu	ine Learning, PHI Lea ne Learning, Packt Pub	rning P lishing	'vt. L Ltd.	td, 20	)15. 7.				

Course No: 7		Course Name	: Deep Lear	ning		Course Code: MMAE 0105						
<b>Batch:</b> 2024-2026		Programme: M.Sc.	Semester: IV	L	Т	Р	J	Credits	Contact Hrs. Per Week:4	s. 4		
		Mathematics		3	0	2	0	4	Total Hours: 4	0		
Total Evalua	ntion I	<b>Marks:</b> 100	Examination Duration: Mid Term (2 hours), End Term (3 hours)									
Theory Asse Internal Ass	essme sessm	nt: 75 Marks ent: 25 Marks	Pre-requisi	Pre-requisite of course: Nil								
Course	This	course will de	velop a pro	found	l unde	rstandi	ng of	deep learni	ng techniques a	nd their		
Objectives	applic	cations to real-	life data pro	blem	s. This	s cours	e incl	udes the co	ncept of neural	network		
	(artifi	cial, deep, rec	urrent) and	its o	ptimiz	ation.	Furthe	r, a genera	understanding	of deep		
	gener	ative models w	ill be develo	ped i	n this	course.	. This	course focu	ses on employab	ility and		
	skill development aligned with all CO's.											
	Alter	studying these t	opics, the su	udent	s will t		10:					
Course		Learn the fund		ept o	a the deep	learnin	lg.					
Outcomes	$CO_2$ :	Identify suitable	le deep learn	ing te	cnniqu	es to re		data proble	ns.			
	CO3:	Understand the	concept of f	neura	l netwo	ork (arti	ificial,	deep, recurr	ent) and its optim	nization.		
	CO4:	Develop deep g	generative m	odels			~					
			COL	JRSE	E SYL	LABU	S			1		
Module No.					Conte	ent				Hours		
Ι	[Course Outcome (s) No.: 1 and 2] Artificial Neural Network: Introduction, connectionism theory of human mind, McCulloch–Pitts unit and Threshold logic, Linear Perceptron, Perceptron Learning Algorithm, feed-forward networks, input, hidden and output layers, organization of neural networks. Estimation of the weights, different learning modes, Multilayer Perceptron. Deep Neural Network: Architectures, Properties of CNN representations: invertibility, stability, invariance, convolution, pooling of layers, CNN and Tensorflow, Difficulty of training deep neural networks, Greedy layerwise training. Neural network optimization: Different optimizers for neural networks- Adaptive Gradient Algorithm (Adagrad), Adadelta, Root mean square propagation (RMSprop),						20					
п	Adaptive moment estimation (Adam), Nesterovaccelerated gradient (NAG). Saddle point problem in neural networks, Regularization methods (dropout, drop connect, batch normalization). [Course Outcome(s) No.: 3 and 4] Recurrent Neural Networks (RNNs): Long short term memory (LSTM) and Gated recurrent unit (GRU), Encoder-decoder architectures, Auto-encoders (standard, de- noising, contractive, etc), Variational Autoencoders, Kohonen Self organizing map (SOM): Back propagation through time, Long Short Term Memory, Gated Recurrent Units, Bidirectional LSTMs, Bidirectional RNNs. Reinforcement learning in neural network, Restrictive Boltzmann Machines (RBMs), gradient computations in RBMs, Deep Boltzmann Machine, Markov Chain Monte Carlo							20				
	(MCN and A	MC) and Gibbs llexNet.	Sampling for	r Dee	p Lear	ning, C	Convol	ution neural	networks: LeNet			
Text Books:												
A. Co Learn C. M.	ourvill ing se . Bisho	e, I. Goodfellow ries), MIT Press op. Neural Netw	v & Y. Bengi s, 2016. vorks for Patt	o, De ern R	ep Lea ecogni	rning ( tion. C	Adapt	ive Computa on Press, 199	tion and Machine	e		
		.,				, ,		, ->>				
Reference B → N. Bu Intelli	o <b>ok:</b> iduma igence	& N. Locascio, Algorithms, O	Fundamenta Reilly Media	als of a, 201	Deep I 17.	Learnin	ig: Des	signing Next	-Generation Mac	hine		

Course No: 8	8 Course Name: Multivari	ate Analysis and Stochastic Proc	ess	es	Co	our	se Code	: MMAE	0106		
Batch:	Programme: M.Sc.	Semester: IV	L	Т	P	J	Credits	Contact Per We	Hrs ek: 4		
2024-2026	Mathematics		3	0	0 2	0	4	Total Ho	Total Hours: 40		
Total Evalua	ntion Marks: 100	Examination Duration: Mid Term (2hours), End Term (3 hours)									
Theory Asso Internal Ass	essment: 75 Marks sessment: 25 Marks	Pre-requisite of course: Nil									
Course Objective	This course will develop a profound understanding of multivariate statistics and stochast processes. The students will learn the concepts of different multivariate distributions alon with their applications. Under this course, the students will also learn the concepts of Markov chains. Further a deep understanding of associations between sets of variables an important patterns within data along with the concepts of Poisson, Birth, Death an Renewal processes will be developed in this course. This course focuses on employability ar skill development aligned with all CO's. After studying these topics, the students will be able to:										
Course Outcomes	<ul> <li>CO1: Understand and apply the fundamental concept of multivariate data analysis.</li> <li>CO2: Learn different multivariate distributions and apply them to real-life problems.</li> <li>CO3: Discriminate objects under study and assess the adequacy of classification.</li> <li>CO4: Identify and quantify the associations between the sets of variables and important pattern within the data.</li> <li>CO5: Understand and underlying concepts of stochastic processes.</li> <li>CO6: Model systems and phenomena that appear to vary in a random manner.</li> <li>CO7: Understand the concept of Markov chains and classification of states.</li> <li>CO8: Learn Poisson, Birth, Death and Renewal processes and their applications in variou scenarios.</li> </ul>										
	Γ	COURSE SYLLABUS							**		
Module No.		Content							Hours		
I	[Course Outcome(s) No.: 1, 2, 3 and 4] Multivariate normal distribution, moment generating function and Characteristic function, marginal and conditional distributions, multiple and partial correlation coefficients. Wishart distribution and its properties. Distribution of Hotelling's T ² statistic, Mahalanobis' D ² , and their applications. Discrimination between two multivariate normal populations, Principal components, their maximum likelihood estimators and sample variances, Canonical correlations and										
	factor scores.		1 4			Juan					
п	[Course Outcome(s) No.: 5, 6, 7, 8 and 9] Two state Markov sequences, Markov chains, determination of n-step transition probabilities, Chapman-Kolmogorov equations, first return and first passage probabilities, classification of states, communicating states, periodicity, stationary probability distributions and limit theorems for ergodic chains. Continuous time Markov processes, Poisson (point) process, Inter arrival time										
	distribution, Random walk and Brownian motion as a random walk, gambler's ruin problem. Birth and death processes, renewal processes, renewal processes-ordinary, modified, equilibrium, renewal functions. Integral equation of renewal theory. Distribution of the number of renewals. The elementary renewal theorem, Queueing Theory: M/M/1, M/M/k and M/G/1 queueing processes										

- > T. W. Anderson, An Introduction to Multivariate Statistical Analysis, Wiley, 2009.
- ▶ R. A. Johnson, & D. W. Wichern, Applied Multivariate Analysis, Wiley, 2002.
- M. S. Srivastava, & C.G. Khatri, Introduction to multivariate statistics, North-Holland, 1979.
- N. C. Giri, Multivariate statistical inference, Academic Press, 1977.
- S. R. Adke & S. M. Manjunath, An Introduction to Finite Markov Processes, Wiley Eastern, 1984.
- E. Cinlar, Introduction to Stochastic Processes, Prentice Hall, 1975.
- ▶ W. Feller, Introduction to Probability and Applications, New Age India International, 1968.
- T. E. Harris, The Theory of Branching Processes, Springer Verlag, 1963.

- A. M. Kshirsagar, Multivariate analysis, Marcel Dekker, 1972.
- R. J. Muirhead, Aspects of Multivariate Statistical Theory, Wiley Interscience, 1982.
- A. C. Rencher, Multivariate Statistical Inference and its Applications, Wiley Interscience, 1998.
- P. G. Hoel, S. C. Port, & C. J. Stone, Introduction to Stochastic Processes, University Book Stall, 1991.
- S. Karlin, & H. M. Taylor, A First Course in Stochastic Processes, Academic Press, 1995.
- > J. Medhi, Stochastic Processes, New Age India International, 2012.
- S. M. Ross, Stochastic Processes, John Wiley & Sons Inc, 1996.

Course No: 9		Course Name	Name: Big Data AnalyticsCourse Code: MMAE 0107									
Batch:		Programme: M.Sc.	Semester: IV	L	Т	P	J	Credits	Contact Hrs Per Week:4			
2024-2026		Mathematics		3	0	2	0	4	Total Hours: 4	)		
Total Evalua	ation I	Marks: 100	Examinatio	Examination Duration: Mid Term (2 hours), End Term (3 hours)								
Theory Ass Internal As	essme sessm	nt: 75 Marks ent: 25 Marks	Pre-requisi	ite of	cours	e: Nil						
Course Objective	This real-l Map apply on en	course will dev ife data problen Reduce and Bi ing algorithms poloyability and	elop a basic ns. The stude ig SQL. Furt to find simil- skill develop	Plop a basic understanding of big data and appropriate techniques to so is. The students will learn to analyze the big data with tools like Hado g SQL. Further, a deep understanding of Managing streaming data, to find similar items will be developed in this course. This course focu- skill development aligned with all CO's								
Course Outcomes	After studying these topics, the students will be able to: CO1: Understand the basic concept of Big data. CO2: Apply appropriate techniques to solve real-life data problems. CO3: Analyze big data with tools like Hadoop, MapReduce and Big SQL. CO4: Manage streaming data, and apply algorithms to find similar items. COURSE SYLLABUS											
Module No.	o. Content							Hours				
I	[Course Outcome(s) No.: 1, 2 and 3] Introduction to Big Data, Characteristics of Big Data and Scalability. Hadoop: History of Hadoop, Apache Hadoop, Analysing Data with Unix tools, Analysing Data with Hadoop, Hadoop Distributed File System. Map Reduce: Anatomy of a Map Reduce Job Run, Failures, Job Scheduling, Shuffle and Sort, Task Execution, Map Reduce Types and Formats, Map Reduce Features. Hadoop Ecosystem: Pig Hive Hbase Big SOI						20					
П	Inductor Ecosystem: Fig. Filve, Hoase, Big SQL.[Course Outcome(s) No.: 4]Near-Neighbor search, Shingling documents, Similarity preserving summary of sets, Different distance measures, Locality sensitive hashing and its applications.Mining data streams: Stream Data model, Sampling data in a stream, Filtering streams, counting distinct elements in a stream, Application of stream algorithms in counting.Finding Frequent Items: Market-Basket Analysis, Market-baskets and Apriori algorithm, Limited pass algorithms, Counting frequent sets in a stream.Link Analysis: Page Rank, Computation of Page Rank, Topic sensitive page rank, Link spam.							20				
Text Books:	skovec	: A Rajaraman	& I D Ulli	nan	Minin	o of Ma	ssive I	Datasets, Ca	mbridge Universi	v Press		
2020			, <i>22 J. D</i> . Oli				. 001	- unioens, eu		., 11000,		
▶ Z. Ra	idtka 8	α D. Miner, Had	loop with Py	thon.	O'Rei	lly Med	1a, 201	0.				
References I	Books: hite, H	: Iadoop - The De	efinitive Guid	le, O'	Reillv	Media.	2012.					
➢ S. Ac	harya	, & S. Chellappa	an, Big Data	and A	Analyti	cs, Wil	ey, 201	15.				

Course No:	10	Course Name	: Cloud Com	putin	g	Cours	se Cod	le: MCAE 0	306		
Batch:		<b>Programme:</b> M.Sc.	Semester:	L	Т	Р	J	Credits	Contact Hrs Per Week:3		
2024-2026		Mathematics	IV	3	0	0	0	3	Total Hours:30	)	
Total Evalua	ntion I	Marks: 100	Examination Duration: Mid Term (2 hours), End Term (3 hours)								
Theory Asso Internal Ass	essme sessm	nt: 75 Marks ent: 25 Marks	Pre-requisi	ite of	cours	se: Nil					
Course Objective Course Outcomes	This of Practic concerns skill of After CO1: CO2: CO3: CO4: CO5: CO6: CO6: CO7:	course covers aims to explain various technologies related to Cloud Computing and their cal implementations, discuss different architectural models of cloud computing, the pts of virtualization and cloud orchestration. This course focuses on employability and levelopment aligned with all CO's. studying these topics, the students will be able to: Describe importance of virtualization along with their technologies like system, network, and storage virtualizations. Identify the architecture and infrastructure of cloud computing, including SaaS, PaaS, IaaS, XaaS, Public Cloud, Private Cloud, Hybrid Cloud and the core issues of cloud computing such as security, privacy, and interoperability. Justify the need of new technology of Virtualization & Cloud Computing and its ecological impact. Identify the known threats, risks, vulnerabilities and privacy issues associated with Cloud based IT services. Apply fundamental concepts in cloud infrastructures to understand the tradeoffs in power, efficiency and cost. Identify the Challenges in managing heterogeneous clouds. Analyze various cloud programming models and apply them to solve problems on the cloud								their and etwork, aaS, d n Cloud power, the	
	CU8:	Describe the k	conponer	ITS OF	Amaz E <b>SVI</b>	I ARI	Servic	e.			
Module No						ent	5			Hours	
	[0]	<b>0</b>	N. 1 0 0	1	Com					nouis	
I	Over Tradi mode Comr Work Virtua enviro deplo Layer study Work Cloud player vendo	view of Cloud tional vs. Clou ls (IaaS, PaaS nunity Cloud), J king with Priva alization techno ilization in Clo comment, Concep yment models, r, Virtualization on (one out of king with Publi d, When to opt rs. Infrastructu ors, Software as e, IBM or Racks	<b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Computing</b> <b>Comp</b>	g- Bring, In oud c Chall concept rer vi- ng. B Clouc ud Ve ud M Open concept loud, vice ( mplen	ef his nporta leploy enges ot of F rtualiz usines l, Cha endors anage Stack, ot of F Public Offerin nentin	story an nce of ment m of Clou lypervis cation, V ss cases racterist , Privat ment L Eucaly bublic C c Cloud ngs, Iaa g public	d Evo Cloud nodels d Con sor, Ba VM m for th tics of te Clou ayer), ptus, I loud, I l Servia aS Ve c cloud	elution of C l Computing (Public, Prinputing. sics of virtua igration tec ne need of O Private Cloud Building Virtual Priv BM or Micro mportance of ce Models, a ndors, PaaS l (one out of	loud Computing, g, Cloud service vate, Hybrid and alization, hniques, Role of Cloud computing ud, Private Cloud blocks (Physical vate Cloud. Case osoft). of Public and Public Cloud offerings, PaaS AWS, Windows	20	

	[Course Outcome(s) No.: 4, 5, 6, 7 and 8]	
	Overview of Cloud Security -Security concerns in Traditional IT, Challenges	
	in Cloud Computing in terms of Application, Server, and Network Security. Security	
	reference model, Abuse and Nefarious Use of Cloud Computing, Insecure Interfaces and	
	APIs (Malicious Insiders, Shared Technology Issues, Data Loss or Leakage, Account or	
	Service Hijacking, Unknown Risk Profile), Attacks in Cloud Computing, Vendors	
	offering Cloud Security for public and private clouds.	
	Overview of Multi-Cloud Management Systems- Explain concept of multi-cloud	
	management, Challenges in managing heterogeneous clouds, benefits of multi-cloud	
II	management systems. Case study on Multi-Cloud Management System (Right Scale	20
	Cloud Management System)	
	Business Clouds- Cloud Computing in Business, Various Biz Clouds focused on	
	industry domains (Retail, Banking and Financial sector, Life Sciences, Social	
	networking, Telecom, Education). Cloud Enablers (Business Intelligence on cloud, Big	
	Data Analytics on Cloud), Role of Cloud computing in SCM and CRM. Future	
	directions in Cloud Computing - Future technology trends in Cloud Computing with a	
	focus on Cloud service models, deployment models, cloud applications, and cloud	
	security. Migration paths for cloud, Selection criteria for cloud deployment. Current	
	issues in cloud computing leading to future research direction.	
Text Book:		

▶ R. Buyya, J. Broberg & A. Goscinski, Cloud Computing: Principles and Paradigms, Wiley, 2011.

- A. Velte, T. Velte & R. Elsenpeter, Cloud Computing A Practical Approach, McGraw Hill Education, 2010.
- J. F. Ransome & J. W. Rittinghouse, Cloud Computing: Implementation, Management and Security, CRC Press Inc, 2009.
- ▶ B. Sosinsky, Cloud Computing Bible, Wiley, 2011.
- J. Rhoton & R. Haukioja, Cloud Computing Architected: Solution Design Handbook, Recursive Limited, 2011.
- R. L. Krutz, & R. D. Vines, Cloud Security: A comprehensive Guide to Secure Cloud Computing, John Wiley & Sons, 2010.
| Batch:                         | Data and more as                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                 |                                     | 0                                        | Cours                                   | e Cou                                 | e: MCAL U                             | 572                           |          |
|--------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------|-------------------------------------|------------------------------------------|-----------------------------------------|---------------------------------------|---------------------------------------|-------------------------------|----------|
|                                | Programme:<br>M.Sc.Semester:<br>IVLTPJCreditsContact Hrs<br>Per Week:2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                 |                                     |                                          |                                         |                                       |                                       |                               |          |
| 2024-2026                      | Mathematics                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                 | 0                                   | 0                                        | 2                                       | 0                                     | 1                                     | Total Hours:20                | )        |
| Total Evaluat                  | tion Marks: 100                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Examinatio                                                      | on Du                               | iratio                                   | n: End                                  | Term                                  | (2 hours)                             | <u> </u>                      |          |
| Internal: 50 ]<br>External: 40 | Marks<br>Marks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Pre-requisi                                                     | te of                               | cours                                    | e: Nil                                  |                                       |                                       |                               |          |
| Course<br>Objective            | This lab aims to unde course focuses on em                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | rstand the co<br>ployability a                                  | ncep<br>nd sk                       | t of clo<br>ill deve                     | ud and<br>elopme                        | virtua<br>nt alig                     | lization by t<br>ned with all         | he help of VMwa<br>CO's.      | re. This |
| Course<br>Outcomes             | After studying these t<br>CO1: Understanding<br>CO2: Understanding<br>CO3: Explain the key                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | topics, the stu<br>about the vir<br>of CISCO pay<br>y component | ident<br>rtualiz<br>acket<br>s of A | s will b<br>zation l<br>tracer<br>Amazor | e able<br>by the f<br>to build<br>web S | to:<br>nelp of<br>d a clou<br>Service | VMware.<br>ud network i<br>and Micros | infrastructure.<br>oft Azure. |          |
| Module No                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                 |                                     |                                          | ent                                     | 6                                     |                                       |                               | Hours    |
| I                              | Jodule No.         Content           1. a) Introduction to Packet Tracer.         b) Network Topologies. (Including explanation of Simple PDU & amp; Complex PDU.)           2. Connecting 3 netwoks using routers. Also, configure DHCP and DNS server.         3. Configuration of different Application services (SMTP, FTP, HTTP, TFTP, DHCP & DNS)           4. Configuration of Vlan and Inter- Vlan Routing.         5. Configure GRE over IP tunnel (VPN).           6. Static NAT configuration.         7. Configure different IoT devices.           9. Study on VMware         a. Creating a VM           b. Networking on VM         c. Merging and splitting disk on VM           d. Cloning the guest OS         e. Deploying VM with template           f. Creating a EC2 instance on AWS         11. Configuration of db in AWS.           12. Creation of S3 bucket with single IAM user in AWS. |                                                                 |                                     |                                          |                                         |                                       |                                       |                               | 20       |

Course No:	Vo: 12         Course Name: Statistical Inference         Course Code: MMAE 0108									
Batch:	Programme:	Semester:	L	Т	Р	J	Credits	Contact Hrs		
2024-2026	M.Sc. Mathematics	III/IV	2	0	2	0	4	Per Week:4	h	
Total Evalua	ation Marks: 100		) . D	0			(21)		J	
I Utal Evalua		Examinatio	on Di	iratio	<b>n:</b> M1d	Term	(2 hours),	End Term (3 hour	rs)	
Theory Asso Internal Ass	essment: 75 Marks sessment: 25 Marks	Pre-requisi	te of	cours	e: Prob	ability	theory and	Distributions		
Course	This course will deve	elop a profou	nd ui	ndersta	nding o	of estin	nators, their	characteristics ar	nd types.	
Objective	The students will lea	arn the conce	epts	of poin	it and i	nterva	l estimation	ns and be able to	test the	
	hypothesis. Further,	a deep under	stand	ing of	large sa	ample	tests and no	on-parametric tests	s will be	
	with all CO's.	urse. This co	ourse	locuse	es on el	npioya	adinty and	skill development	angned	
	After studying these	topics, the stu	ıdent	s will t	be able	to:				
Course	CO1: Understand the	e concept of a	ı Stat	istic an	d use i	t for es	stimation pu	rpose.		
Outcomes	CO2: Understand th	e notions of	estin	nation 1	theory	and ap	ply it to de	erive various estin	nates for	
Outcomes	CO3: Apply the theorems directly to obtain the best estimates for the parameters.									
	<b>CO3:</b> Apply the theorems directly to obtain the best estimates for the parameters. <b>CO4:</b> Differentiate between the concepts of point estimation and interval estimation and use									
	them efficient	ly.	1	1						
	<b>CO5:</b> Apply hypothe	esis testing for	r botl	ı simpl	e and c	ompos	site cases.			
	<b>CO6:</b> Understand and apply large sample tests.									
	COT. Understand the	COI		E SYL		<u>anu ne</u> S	ni-paramen	ic methods of esti-		
	T								<b>TT</b>	
Module No.	[Course Outcome(s	$(x) N_0 \cdot 1 2 3$	hee		ent				Hours	
	Estimation Theory	Parameters	statis	דן tic_est	imator	chara	cteristics of	a good estimator		
	consistency, Unbiase	dness, Suffic	iency	-factor	ization,	theore	em, Minima	l Sufficiency.		
Ι	Efficiency-Most Ef	ficient estin	nator	, Mini	imum	Varia	nce Unbia	sed (M. V. U.)	20	
	Estimators. Comple	eteness, Leh	manı	n-schef	fe's t	neoren	n, Rao-Bla	ckwell theorem,		
	Uniformly minimum	variance unb	nasec	l estima	ator (U. kalibor	MVUE	E). motion Mo	thad of Moments		
	Method of Least Squ	ares confide	nce i	iuiii Li Marvala	s and it	e const	mation, Me	mean & variance		
	of a normal population	on confidence	e lim	its		5 001130		incan & variance		
	Course Outcome	$(\mathbf{x}) \mathbf{N} 0 : 5 \cdot 6 \mathbf{a}$	nd 7	1						
	Testing of Hypothe	sis: Most Po	werf	ı ul Test	(MP).	Unife	ormly Most	Powerful (UMP)		
	tests, Likelihood Rat	io Tests, Tes	ting	for me	an and	equali	ty of varia	nces for a Normal		
II	Population.			_					20	
	Large Sample Tests	Test of sign	nifica c	nce of	large s	ample	s, Sampling	of attributes, test		
	for single proportion	i, test for dif	feren ndar	ce of j devia	proport	ions, to	est of signi	ficance for single		
	Non-Parametric Te	sts: Sign Tes	t, Sig	ned Ra	ank Tes	st, Med	lian Test, N	Iann-whitney test,		
	Run Test, one samp	le Kolmogor	ov-Si	nirnov	test, k	Kruska	l-Wallis tes	t. (Properties and		
	Applications based, r	no proofs)								
Text Books:	Dobtagi Statistical I	nforence De		ublicat	iona or	12				
$\sim$ V.K	Rao Linear Statistical	al Inference a	nd its	applic	cons, 20	Wilev	2009			
Defemence D	ooks	u		"PPIIC		,, ney	, _007.			
$\mathbf{k}$ elerence $\mathbf{B}$	ouks: asella & R. L. Berger	Statistical In	feren	c. Ceno	page Ind	lia Priv	vate Limited	. 2007.		
> R. Ho	ogg, A Craig, & J. Mc	Kean, Introd	uction	n to Ma	athema	tical St	tatistics, Pea	arson, 2012.		
	-									

Course No:	No: 13 Course Name: Actuarial Statistics Course Code: MMAE 0109										
Batch:	]	Programme: M.Sc.	Semester:	L	Т	Р	J	Credits	Contact Hrs Per Week:4		
2024-2026		Mathematics	III/IV	3	0	2	0	4	Total Hours: 4	0	
Total Evalua	tion N	<b>farks:</b> 100	Examinatio	on Du	iratio	n: Mid	Term	(2 hours), I	End Term (3 hou	rs)	
Theory Asse Internal Ass	essmei essme	nt: 75 Marks ent: 25 Marks	Pre-requisi	ite of	cours	se: Nil					
Course Objective	This c learn probal emplo	ourse will deve the related co pility models re yability and sk	elop a basic u oncepts to i elated to actu ill developm	inders insura iaries ent ali	tandir nce a will t gned	ng of vit and anr be devel with all	tal stati nuities. loped i CO's.	istics and lif Further, a n this cours	e tables. The stud deep understar e. This course fo	ents will iding of cuses on	
Course Outcomes	After 5 CO1: CO2: CO3: CO4:	After studying these topics, the students will be able to: CO1: Understand the concept of vital statistics and life tables. CO2: Understand and apply probability models related to actuaries. CO3: Analyze claims by the use of poisson distribution. CO4: Learn and understand the related concept to insurance and annuities. COURSE SYLLABUS									
	r			UKSE	SYL	LABU	5				
Module No.					Cont	ent				Hours	
Ι	[Course Outcome (s) No.: 1, 2 and 3] Utility theory, insurance and utility theory, models for individual claims and their sums, survival function, curtate future lifetime, force of mortality. Life table and its relation with survival function, examples, assumptions for fractional ages, some analytical laws of mortality, select and ultimate tables. Multiple life functions, joint life and last survivor status, insurance and annuity benefitsthrough multiple life functions evaluation for special mortality laws. Multiple decrement models, deterministic and random survivorship groups, associated single decrement tables, central rates of multiple decrement, net single premiums and theirnumerical evaluations.										
II	[Cour Princip forceo compo- Life in ofdeat benefi contin comm apport Net premin benefi accum reserv duration content some ofexpo-	rse Outcome (sples of comport f interest and bunding. nsurance: Insur- h-level benefit tinsurance, rec- uous life annuit premiums: C- ums, apportiona ts.Payment pre- pulation typebe e, reserves on es on an appons, allocation ons for reserve practical consi-	s) No.: 4] und interest. discount, d rance payable insurance, d cursions, con- ities, discret ns, varying a ies-due. ontinuous able premiu oremiums, a nefits.Net pr- asemicontinu ortionable on s, commutati derations: Pro- olicy expension	Nom compo e at t endow nmuta e life unnuit and ums, apport emiur uous b ordisco to po to po to po to po to po	inal a bund he mo ment tion f annui ies, re discre comr ionab n rese basis, bunted licy nction ms tha	nd effer interest oment of insurar function ties, lif cursion ete pre nutation le pre rves: Cor reserve l contir years, re s. at inclue	ctive ra , accu of death nce, di ns. Life Yeannui s, com emiums ontinue s based nuous ecursive de exp	ates of inter imulation fa h and at the ferred insur e annuities: ities with m pleteannuiti s, true m ctions, acc s, commuts ous and disc d on true me basis, reser e formulas enses-gener butions ar	rest and discount actor, continuous e end of the year ance and varying Single payments, onthly payments, es-immediate and onthly payment cumulation type ation functions rete net premiums, ves at fractional and differential	20	

- M. E. Atkinson & D.C.M. Dickson, An Introduction to Actuarial Studies, Edward Elgar Publishing, 2000.
- T. Bedford & R. Cooke, Probabilistic Risk Analysis: Foundations and Methods, Cambridge University Press, 2001.
- N. L. Bowers, H. U. Gerber, J. C. Hickman, D. A. Jones & C. J. Nesbitt, Actuarial Mathematics, Society of Actuaries, 1997.
- P. K. Medina, & S. Merino, Mathematical Finance and Probability: A Discrete Introduction, Birkhauser Verlag AG, 2003.
- A. Neill, Life Contingencies, Butterworth-Heinemann, 1977.

- P. Booth, R. Chadburn, D. Cooper, S. Habermann & D. James, Modern Actuarial Theory and Practice, Chapman and Hall, 1998.
- T. Rolski, H. Schmidli, V. Schmidt & J. Teugels, Stochastic Processes for Insurance and Finance, John Wiley, 1998.
- E. F. Spurgeon, Life Contingencies, Cambridge University Press, 2011.

Course No:	14	Course Name	: Statistical	Comj	puting	Cours	e Cod	e: MMAE (	)111	
Batch:		Programme: M.Sc.	Semester:	L	Т	Р	J	Credits	Contact Hrs Per Week:4	
2024-2026		Mathematics	IV	3	0	2	0	4	Total Hours: 4	0
Total Evalua	tion I	<b>Marks:</b> 100	Examinatio	on Du	iratio	n: Mid	Term	(2 hours), I	End Term (3 hour	rs)
Theory Asse Internal Ass	essme sessm	nt: 75 Marks ent: 25 Marks	Pre-requisi	te of	cours	e: Stoc	hastic	Processes		
Course Objective	This of Statis under be de with a	course will dev tics. This cours standing of sim veloped in this all CO's.	elop a profou se also inclue nulation of da course. This	and u des n ata th cours	ndersta umeric rough e focus	nding al metl differer ses on e	of the nods fo nt proc employ	computation or solving p edures and vability and	nal methods appli problems. Further Monte-Carlo met skill development	cable to , a deep hod will aligned
Course Outcomes	After studying these topics, the students will be able to: <b>CO1:</b> Understand the Computational methods applicable to statistics. <b>CO2:</b> Apply numerical methods for solving problems. <b>CO3:</b> Simulate data through different procedures. <b>CO4:</b> Understand and apply Monte Carlo methods. <b>COURSE SYLLABUS</b>									
Module No.	Content He									
I	ContentH[Course Outcome(s) No.: 1 and 2] Concept of central limit theorem and Markov chain. Pseudo-Random number generation, tests, Requisites of a good random number generator, Generation of random observations through inverse cdf, acceptance rejection and transformation methods. Simulation of Random Walk process. Numerical methods: Vector and matrix operations, Interpolation. Numerical root finding, matrix factorization. Eigenvalue and eigenvectors, simple optimization method- direct search, grid search, interpolatory search, gradient search. Newton-Raphson									20
П	[Cou Expect data a Methe integr Carlo	rse Outcome(s ctation-Maximiz and mixture mod ods to compu- cation. Monte C methods. Metro	s) No.: 3 and zation (EM) A dels. te integrals: Carlo Method opolis- Hastin	<b>1 4]</b> Algor Qua s: Mo ngs an	ithm and drature Cannot	nd App form arlo int bs sam	lication ula, d egratio pling a	ns: EM algo ouble integ on and appli nd related n	rithm for missing gration, Gaussian cations of Monte nethods.	20
Text Books: → S. V. → C. P. Reference Be	Buure Rober	en, Flexible Imp t & G. Casella,	Monte Carlo	issing Stati	g Data, stical N	Chapm Aethod	an and s, Sprin	Hall/CRC, 2 nger-Verlag,	2012. 2010.	on and
W. K. Hall/C	CRC, 1	s, S. Kichardson 1995.	a D. Spiege	maite	er, Mai	KOV Cľ	iani M	onte Cario I	ii Fractice, Chapm	ian and

> W. J. Kennedy & J. E. Gentle, Statistical Computing, Routledge, 2021.

Course No:	15	Course Name: Art	ificial Intelligence for Data S	Scie	ence	Co	urs	e Code:	MMAE (	0112
Batch:		Programme: M.Sc.	Semester:	L	T	Р	J	Credits	Contact Per Wee	Hrs ek: 4
2024-2026		Mathematics	III/IV	3	0	2	0	4	Total Ho	ours: 40
Total Evalua	tion 1	Marks: 100	<b>Examination Duration:</b> M	id T	erm	n (2	ho	urs), Enc	l Term (3	hours)
Theory Asso Internal Ass	essme sessm	nt: 75 Marks ent: 25 Marks	Pre-requisite of course: Ni	1						
Course Objective	This applical algor: techn focus	course will develop cations to real-life thm in problems to iques to read text, he es on employability	a profound understanding of data problems. This course find the optimal solution que ar speech, and interpret it will and skill development aligned	Art incl iick l be wit	ifici udes ly. I dev th al	al I s th Furt elop 1 CC	nte le a her ped D's	lligence in this contract.	methods a ons of op understar ourse. Thi	nd their timizing nding of s course
Course Outcomes	After CO1 CO2 CO3 CO3	studying these topic Identify suitable A Understand the four Apply Optimizing a Apply techniques to	s, the students will be able to: rtificial Intelligence methods t ndations of Artificial Intellige algorithm to problems to find to pread text, hear speech, and ir	to render	eal-li optin	ife c mal it.	lata sol	a problem ution qui	ıs. ckly.	
			COURSE SYLLABUS							
Module No.			Content							Hours
I	[Cou The A State A*. L Minin probl Logic chain Ontol	rse Outcome(s) No. AI problems, AI tech space search, Uninfo ocal search and opti- nax algorithm, alp ems. al agents, Propositi ing, backward ch ogies, Semantic web	<b>: 1 and 2</b> ] nique, philosophy and develop ormed and informed search te mization: hill-climbing, simul ha-beta pruning, stochastic tional logic, First-order log naining, resolution, Knowl o and RDF.	ome chn atec gar ic, ledg	nt o ique l anr nes, Infe ge	f An es: E neal Co eren repr	rtifi 3FS ing ons ce ce	cial intel , A*, var traint- sa in FoL: entation:	ligence. riations of atisfaction forward Frames,	20
Π	[Cou Facts objec datab Proba Natu Trans Trans and A	rse Outcome(s) No and predicates, data ts, use of cut and f ase. bilistic reasoning, B ral language Und formational Gramu ition Networks from TN's- Issues and Ap	<b>b: 3 and 4]</b> a types, goal finding, backtra fail predicates, recursion, list ayesian networks, Fuzzy logic <b>erstanding</b> : Introduction to mars of Natural Languag Grammar to Acceptor. Two pplications.	ickii s, s c. o L e, Lev	ng, s imp angu Two el P	simp le i lage o-Le roce	ple npu es eve	object, c at/output, and Gra l Repre ng Syste	compound dynamic ammars - esentation, ms RTN's	20
Text Book: → D. Kl Reference Bo → S. Ru	neman p <b>ok:</b> ssell &	i, First Course in Art & P. Norvig, Artificia	tificial Intelligence, McGraw- al Intelligence: A Modern Apr	Hill oroa	Edu ich,	icat Pea	ion rso:	, 2018. n Educati	ion: Uppe	r Saddle

River, 2010.

Course No:	16	Course Name	: Pattern Re	cogni	tion	Cours	e Cod	le: MMAE	0113	
Batch:		Programme: M.Sc.	Semester:	L	Т	Р	J	Credits	Contact Hrs Per Week:4	
2024-2026		Mathematics	III/IV	3	0	2	0	4	Total Hours: 4	0
Total Evalua	tion I	Marks: 100	Examinatio	on Du	iratio	n: Mid	Term	(2 hours),	End Term (3 hou	rs)
Theory Asse Internal Ass	essme essme	nt: 75 Marks ent: 25 Marks	Pre-requisi	ite of	cours	se: Reg Mul	ression tivaria	n Analysis a te Analysis	and Predictive Mo	delling;
Course Objective	This of and re conce algori focus	course will deve egularities with pts of discrimination detect es on employab	elop a basic u their applic nant function unusual patte ility and skill	under ation s for erns i	standi s in re classif n the	ng of al eal-life ication. data wi	lgorith data p Furth ill be c ped wit	ms to auton roblems. T er, a deep u developed i th all CO's	natically recognize he students will 1 inderstanding of c n this course. Thi	e pattern earn the lustering s course
Course Outcomes	After CO1: CO2: CO3:	studying these Apply algorit problems. Implement line Use discrimina	topics, the stu hms to auto ear and non-li- int functions	udent matic inear for cl	s will ally reclassification of the second s	be able ecogniz fiers to t cation.	to: e patto find hio	ern and reg dden pattern	gularities in real-	life data
	<b>CO4</b> :	Understand an	d apply clust	ering	algori	thms to	detect	unusual pa	tterns in the data.	
			COL	JRSH	LSYL	LABU	8			1
Module No.					Cont	ent				Hours
I	Introc Semi- Introc for N Paran Estim Bayes Introc Suppo for M	<b>Course Outcome(s) No.: 1, 2 and 3]</b> Introduction, Features, Feature Vectors, Classifiers, Supervised, Unsupervised and Semi-Supervised Learning. Introduction to Bayes Decision Theory, Discriminant Functions, Bayes Classification for Normal Distributions, Estimation of Unknown Probability Distributions: ML Parameter Estimation, MAP Estimation, Bayesian Inference, Maximum Entropy Estimation, Mixture Models, Non-Parametric Estimation. The Naïve-Bayes Classifier, Bayesian Networks. Introduction to Linear Discriminant Functions and Decisions, Logistic Discrimination, Support Vector Machines for Separable Classes, SVM for Non-Separable Classes, SVM for Multiclass Case.								20
Π	[Cou Non-] Exact Linea Class: Neura Imbal Clust Agglo Datas	rse Outcome(s Linear Classifi Classification r Classifiers, C ifiers, Radial E al Networks, S lance Problem. ering: Introdu omerative Algo ets, Hard Clusto	s) No.: 2 and ers: Two La of Training apacity of d- Basis Function SVM-Nonlin ction, Proxi rithms, Divi ering Algorit	<b>1 4]</b> yer a: Set, dime on Ne ear 0 mity sive hms.	nd Thr The nsiona etwork Case, Meas Algori Algori	ree laye Back-P Il space s, Univ Combi sures, S ithms, i	r Perce ropaga in lin versal ning Sequen Hierard ased of	eptrons, Alg tion Algori ear Dichoto Approxima Classifiers, ntial Cluste chical Algo n Graph Th	gorithms based on ithm, Generalized omies, Polynomial tors, Probabilistic Boosting, Class ering Algorithms, orithms for Large eory, Competitive	20
Text Book: → S. The Reference Bo → _M. N. Scien	Learn eodori <b>ook:</b> Murt tific, 2	ing algorithms. idis & K. Koutr y & V. S. Devi, 2015.	oumbas, Patt	ern R	ecogn attern	ition, A Recogn	cadem ition a	ic Press, 20 nd Machine	008. 2 Learning, World	

Course No:	17 Course Name:				Co	ours	seCode:	MMAE 01	14
	Design of Expe	riments and	Analysis of Varia	nce			1		
Batch:	Programme:	Semester:	L	Т	Р	J	Credits	SContact H Per Weel	Irs k: 4
2024-2026	M.Sc. Mathematics	III/IV	3	0	2	0	4	Total Ho	urs: 40
Total Evalu	ation Marks: 100	Examinati	on Duration: M	id Te	erm	(21	hours), E	 End Term (	3
		hours)							
Theory As Internal A	s <b>essment</b> : 75 Marks s <b>sessment</b> : 25 Mark	Pre-requis	site of course: Ni	1					
Course	This course will de	evelop a bas	ic understanding	of c	lesig	gn a	and appl	ication of	suitable
Objective	designs to real-life	data problen	ns. This course in	nclud	les t	he a	application	on of the r	esult of
	block designs and g	general facto	rial experiments.	Furt	her,	a c	leep und	erstanding	of split
	plot experiment wil	1 be develop	ed in this course.	Thi	s co	ourse	e focuses	s on emplo	yability
	and skill developme	nt aligned wi	th all CO's.						
	After studying these	topics, the s	tudents will be abl	le to:					
Course	CO1: Undestand the	e basic conce	pts of design.						
Juteomoc	CO2: Apply suitable	e designs to 1	eal-lite data probl	lems.	•			CC	
Jucomes	CO3: Estimate cont	rasts and diff	erent effects of the	e des	sign	and	build an	efficient n	nodel.
	CO4: Understand an	nd apply the	result of block des	agns	and	gei	neral fact	orial exper	iments.
	COS: Efficiently ap	ply the conce	ept of split plot ex	perin	nent	. to 1	real-life (	uata proble	ms.
			KSE SILLADUS	)					
Module			Content						Hours
No.									
	[Course Outcome(s	s) No.: 1, 2 a	nd 3]						
	Review of linear e	stimation an	d basic designs.	ANC	OVA	1: F	ixed eff	ect models	
	(Two-way classification)	ation with u	nequal and propo	rtion	al n	um	ber of ol	bservations	
Ι	per cell), Random a	nd Mixed ef	fect models (Two	-way	v cla	ssif	ication w	with m $(>1)$	20
	observations per cel	l).	1						
	Tukey's test, gener	al two-way	classification. Int	ra a	nd 1	inter	r block	analysis of	
	Incomplete block de	sign.							
	[Course Outcome	(s) No.: 3, 4	and 5				_		
	General block desig	in and its inf	ormation matrix (	(C).	Crit	eria	for com	nectedness,	
тт	balanced and orthog	gonality: Ba	lanced Incomplete	e Blo	ock	Des	sign (BIE	3D) – Intra	20
Ш	and inter block analy	ysis, Simple	lattice designs.	•			1.1 1	1	20
	Association schem	es and par	tially balanced	inco	mpl		DIOCK	aesigns –	
	General factorial	anneter luent	factorial effects		ova dv	nan of	$2^n$ and	2nfactorial	
	General lactorial e	xperiments,	hlocks complet	stuc	uy ( und	01 / no	z ^{re} and	5 Tactorial	
	construction of conf	anuonnizeu ounded facto	rial experiments	solit	nlot	pa evt	nual CO	mounding,	1
Fext Rooks	•		mu experiments,	spin	piot		Jerment.		I
$\succ$ M N	• N Das & N Giri Dec	sion and Ana	lysis of Experime	nts 1	New	Ασ	e Puhlish	ers 2017	
	ean & D Voss Desi	on and Anal	vsis of Experimen	ts. S	nrin	ger.	1999	015, 2017.	
> A. E	Dev. Theory of Block	Designs. Wi	lev Eastern, 1986.	,	P111	<i>5</i> <b>0</b> 1,	1777.		
> N. C	Biri, Analysis of Varia	ance, South A	Asian Publishers.	1986					
Deference	Poolzer	,							
	DUUKS: Lochi Lincon Fatim	ation and D.	aign of Evenning	nto T	X/:1-	πD	ostore 1	0.027	
	Montgomery Desi	ation and De	sign of Experiment	ns, v	wile Glass	y E	asterii, I	907.	
► U.L ▶ UT	outenburg & Shalah	gii allu Allaly 5 Statistical	Analysis of Design	.s, W nod I	ney Evn/	, 19 arim	10.	ringer 200	0
▶ П.І	outenouig & Shalabi	i, Statistical	Analysis of Desig		Lxpe		ients, spi	inger, 200	7.

Course No:	18	Course Name	Statistical (	Quality (	Control	Course	<u>e Code</u> :	MMAE 0	115	
Batch:		Programme: M.Sc.	Semester:	L	Т	Р	J	Credits	Contact H Per Week	rs x:4
2024-2026		Mathematics	III/IV	3	0	2	0	4	Total Hou	rs: 40
Total Evalua	tion I	Marks: 100	Examinatio	on Dura	ation: M	id Term	n (2 hou	rs), End T	erm (3 hou	rs)
Theory Asse	essme	nt: 75 Marks	Pre-reauisi	te of co	ourse: N	il				
Internal Ass	sessm	ent: 25 Marks	<b>1</b>							
Course	This c	course will deve	lop a profou	nd unde	rstanding	g of suita	able cha	rts used in	the industri	es. This
Objective	cours	e includes the ci	reation of ins	spection	plans. F	urther, a	basic u	nderstandi	ng of contro	ol charts,
	proce	ss control and j	product cont	rol will	be deve	eloped in	n this c	ourse. This	s course for	cuses on
C	emplo	byability and ski	II developme	ent align	ied with	$\frac{1}{1}$	•			
Course	CO1.	Identify and an	opics, the su	aborto ir	the indu	le lo:				
Outcomes	COI:	Understand the	pry suitable	charts II.	ntrol ch	istiles.	their on	alications		
	$CO_2$	Create sampli	a inspection	pl of co		ants and	inen apj	plications.		
	CO3.	Understand the	basics of pr	ocess co	ntrol and	d produc	et contro	1		
	04.	onderstand the	COU	JRSE S	YLLA	BUS	<i>contro</i>	1.		
Module No.				С	ontent					Hours
I	ContentI[Course Outcome(s) No.: 1 and 2]Statistical Quality Control (S.Q.C.): Introduction, Chance causes and Assignable causes of variation, Benefits of S.Q.C., Process control and product control, Control limits, specification limits and tolerance limits, Tools for statistical quality control.Control charts for variables: $\bar{X}$ and $R$ charts, Criterion for detecting lack of control in these charts, Interpretation of charts.Control chart for standard deviation ( $\sigma$ - chart).Quality control and Sampling Inspection: Basic concepts of process monitoring and control, General theory and review of control charts, O.C and ARL of control charts, CUSUM charts using V-mask and decision intervals, economic design of x- bar chart.[Course Outcome(s) No.: 3 and 4] Control charts for attributes: Control chart for fraction defective (p-chart), Interpretation, Control chart for number of defects per unit (c-chart), c-chart for variable sample size (u-chart), Applications of c-chart.Natural tolerance limits and specification limits, modified control limits. Acceptance sampling inspection plans, Sampling inspection plans for attributes.Review of sampling inspection techniques, single, double, multiple and sequential 									20
Text Books: → D. C. → G. B. Reference H → Schill Hall/0	Mont Weth Book: ling, C CRC, 2	gomery, Introdu erill, Sampling I 6. Edward, Neub 2009.	action to Stat Inspection an bauer & Dear	istical Q ad Quali 1 V, Acc	Quality C ty Contro ceptance	ontrol, J ol, Chap Samplir	ohn Wil man and ng in Qu	ley & Sons Hall, 2013 ality Contr	, 2008. 3. rol, Chapma	n and

Course No:	No: 19Course Name: Bio-StatisticsCourse Code: MMAE 0116									
Batch:	Programme:     Semester:     L     T     P     J     Credits     Contact Hrs       M.Sc.     Mathematics     III/IV     3     0     2     0     4     Total Hours: 40									
2024-2026		Mathematics	III/IV	3	0	2	0	4	Total Hours: 4	0
Total Evalua	tion I	Marks: 100	Examinatio	on Du	iratio	n: Mid	Term	(2 hours), H	End Term (3 hou	rs)
Theory Asse Internal Ass	essme sessm	nt: 75 Marks ent: 25 Marks	Pre-requisi	te of	cours	e: Stati	stical	Inference		
Course Objective	This of applic censo epide	course will deve cations to real- oring techniques mic models will comment aligned	elop a profou life data pr s to model be develope	obler the 1 d in t	ndersta ns. Th eal da his cou	anding ne stud ata. Fu urse. Th	of imp ents v rther, nis cou	oortant surviv will learn th a deep und arse focuses o	val distributions and concepts of derstanding of store on employability	and their different tochastic and skill
Course Outcomes	After studying these topics, the students will be able to: CO1: Understand and apply important survival distributions to real-life data problems. CO2: Analyze epidemiological data and clinical data. CO3: Apply different censoring techniques to model the real data. CO4: Understand stochastic epidemic models and design clinical trials. COURSE SYLLABUS									
	1		COL	JRSF	SYL	LABU	8			
Module No.					Cont	ent				Hours
Ι	[Course Outcome(s) No.: 1, 2 and 3] Functions of survival time, survival distributions and their applications viz. exponential, gamma, Weibull, Rayleigh, Lognormal, death density function for a distribution having bath-tubshape hazard function. Tests of goodness of fit for survival distributions (WE test for exponential distribution, W-test for lognormal distribution, Chi-square test for uncensored observations). Parametric methods for comparing two survival distributions viz. L.R test, Cox's F-test. P-value, Analysis of Epidemiologic and Clinical Data: Studying association between a disease and a characteristic: (a) Types of studies in Epidemiology and Clinical Research (i) Prospective study (ii)Retrospective study (iii) Cross-sectional data, (b) Dichotomous Response and Dichotomous Risk Factor: 2 X 2 Tables (c) Expressing relationship between a risk factor and a disease (d) Inference forrelative risk and odds ratio for 2X2 table, Sensitivity, specificity and predictivities, Coxproportional hazard model. Type I, Type II and progressive or random censoring with biological examples, Estimationof mean survival time and variance of the estimator for type I and type II censored data withnumerical examples. Non-parametric methods for estimating survival								20	
II	[Cou Comp comp Theor Cond Stoch varial Basic rando to equ when linkag Plann aclini design	rse Outcome(s beting risk the etingrisks and eting risks byn ry of independe itional death dem <b>astic epidemic</b> bele technique). biological con ommating, distri- uilibiriumfor X- both naturalse ge in heredity. ing and design cal trial, design ns.	b) No.: 4] ory, Indices their inter-re- naximum like ent anddepen- nsity function <b>models</b> : Sir neepts in ge- bution of alle linked genes, lection and of clinical trias for compara	for elatio elihoo ndent ns. nple netic ele fre , natu muta als, P ative	measins. Esod and risks. and ges, Menoral selution a hase I, trials.	ure-men stimatic l modif Bivari eneral e ndels l y (dom ection, re oper II, and Sample	nt of ied mi ate nc pidem aw, H inant/c mutati rative, III tria e size c	probability probabilities inimum Chi ormal depen ic models (t fardy-Weinb co-dominant on, genetic o detection a als. Consider determinatio	of death under s of death under -square methods dent risk model by use of random erg equilibirium cases), Approach drift, equilibirium nd estimation of ration in planning n in fixed sample	20

- S. Biswas, Applied Stochastic Processes: A Biostatistical and Population Oriented Approach, New Central Book Agency, 2007.
- > D. Collett, Modelling Survival Data in Medical Research, Chapman & Hall/CRC, 2003.
- > D. R. Cox & D. Oakes, Analysis of Survival Data, Chapman and Hall, 1984.
- R. C. E. Johnson, Probability Models and Statistical Methods in Genetics, John Wiley & Sons, 1971.
- ▶ W. J. Ewens, Mathematics of Population Genetics, Springer Verlag, 1979.
- > W. J. Ewens & G.R. Grant, Statistical methods in Bio informatics: AnIntroduction, Springer, 2001.

- L. M. Friedman, C. Furburg, & D. L. DeMets, Fundamentals of Clinical Trials, Springer Verlag, 1998.
- A. J. Gross & V. Clark, Survival Distribution; Reliability Applications in Biomedical Sciences, John Wiley & Sons, 1975.
- > A. Indrayan, Medical Biostatistics, Chapman & Hall/CRC, 2008.
- E. T. Lee & J. Wang, Statistical Methods for Survival Data Analysis, Wiley–Blackwell, 2003.
- C. C. Li, First Course in Population Genetics, Boxwood Press, 1976.

Course No:	20	Course Name:	Data Mining and Wa	rehou	ising	Coi	ırse (	Code: B(	CSE 0152			
Batch:		Programme: M.Sc.	Semester:	L	Т	Р	J	Credits	Contact Hrs Per Week: 3			
2024-2026		Mathematics	III/IV	3	0	0	0	3	Total Hours: 3	0		
Total Evalua	atior	<b>Marks:</b> 100	Examination Dura	tion:	Mid	Terr	n (2 l	nours), E	nd Term (3 hou	rs)		
Theory Asso Internal Ass	essn sessi	nent: 75 Marks ment: 25 Marks	Pre-requisite of co	urse:	D	BM	S					
Course Objective	The Mir CO	e Objective of thi ning techniques. T 's.	s course is to introd 'his course focuses or	uce tl 1 emp	ne ba loyab	sic c oility	conce	pts of Da skill deve	ata Warehouse a elopment aligned	nd Data with all		
Course Outcomes	Afte CO CO CO	<ul> <li>After studying these topics, the students will be able to:</li> <li>CO1: Understand and apply the concept of data warehouse and mining in real-life applicat</li> <li>CO2: Apply the principle algorithms used in modern machine learning.</li> <li>CO3: Apply the information theory and probability theory to get the basic theoretical resul</li> <li>Data Mining.</li> <li>CO4: Apply Data mining algorithms to real datasets, evaluate their performance and appret the practical issues involved.</li> <li>CO5: Implement clustering using various clustering methods on data set.</li> </ul>										
	CO	5: Implement clus	stering using various COURSE S	cluste YLL	ring 1 ABUS	neth S	ods o	n data se	t.			
Module No.		COURSE SYLLABUS Content H										
Ι	[Co Da W Ar OI Da Re M Da Da In Te Aş	Automatical Action of the second state of the	No.: 1, 2 and 3] g: Overview, Differ- dimensional Data Repository, Data V a Cubes Computation g: Data Cleaning, Da Warehouse to a Mu ics of Data Mining g frequent Patterns: E FP-Growth. Multil	rence Moo Vareh s & D ita In iltipro , Issu Basic evel	betw del: ouse data G tegrat ocesso les an Conce Assoc	veen Com & ( ener ion a or An nd A epts ciatio	Data Concept DLAF calizat and D rchite Applic of A on R	abase Sy Hierarc Y Techno tion. Data Trans cture, Mu cations of ssociation ules, Mu	estem and Data hy, Three-Tier ology, Types of sformation, Data ulti-Dimensional of Data Mining n Rules Mining, ulti-Dimensional	15		
11	Cl Pro Ma Da Cl Hi Da Cl Ma Da Da	assification and assification and opagation, Neura achines, Prediction ata Mining Cluss ustering Methods, terarchical Clustor ensity Based Methods LIQUE. odel Based Methods ata, Text Mining, ata Visualization.	<ul> <li>Predictions: Class</li> <li>Prediction, Decisi</li> <li>Prediction, Decisi</li> <li>al Network, Neares</li> <li>n.</li> <li>ster Analysis: Data</li> <li>, Partitioning Method</li> <li>ering: CURE and Chast</li> <li>lethods: DBSCAN,</li> <li>hod: Statistical Appr</li> <li>Web Data Mining, S</li> </ul>	sifica on T t Ne Type s. amele OPI oach, patia	tion Free, eighbo es in con. FICS. Outl I Data	& I Bajour Clu Gr ier J a Mi	Predic yesian Class ster id B Analy ning,	etion, Iss n Classi sifiers, S Analysis, ased Me vsis, Min Tempora	sues Regarding fication, Back Support Vector Categories of ethods STING, ing Multimedia al Data Mining,	15		

J. Han, M. Kamber & J. Pei, Data Mining Concepts and Techniques, Morgan Kauffmann, 2011.

- > M. H. Dunham, Data Mining: Introductory and Advanced Topics, Pearson Education, 2006.
- S. Anahory & D. Murray, Data Warehousing in the Real World: A Practical Guide for Building Decision Support Systems, Addison-Wesley, 1997.
- > P. N. Tan, M. Steinbach & V. Kumar, Introduction to Data Mining, Pearson Education, 2016.
- > C. C. Aggarwal, Data Mining: The Textbook, Springer, 2015.

Course No: 2	21	Course Name: Da	ata Mining and Warehous	ing L	ab	Cou	rse	Code: B	BCSE 018	1
Batch:		Programme: M Sc	Semester:	L	T	Р	J	Credits	Contact Per We	Hrs. ek: 2
2024-2026		Mathematics	III/IV	0	0	2	0	1	Total Ho	ours: 24
Total Evalua	ation 1	<b>Marks:</b> 100	Examination Duration	: Mi	d Te	rm (2	2 ho	urs), End	d Term (3	hours)
Internal: 50 External: 40	Mark ) Mar	cs ks	Pre-requisite of course	:	DBN	/IS L	ab			
Attendance:	10 M	larks								
Course	The	Objective of this co	ourse is to implement a	nd ru	ın th	e pro	ogra	amme ba	used on th	ne basic
Objective	conce emple	epts of Data War	rehouse and Data Min evelopment aligned with a	ing ll CC	tech )'s.	niqu	es.	This co	ourse foc	uses on
Course	After	studying these topic	s, the students will be able	e to:						
Outcomes	CO1: CO2:	: Implement the clust : Implement SVM or	tering technique like DBS n two dimensional data set	CAN	I, K-1	NN, I	ΚM	lean.		
			COURSE SYLLAB	US						
Module No.			Content							Hours
I	<ul> <li>D</li> <li>D</li> <li>al</li> <li>D</li> <li>al</li> <li>D</li> <li>al</li> <li>D</li> <li>D</li> <li>al</li> <li>D</li> <li>D</li> <li>base</li> <li>Ir</li> <li>Ir</li> <li>Ir</li> <li>Ir</li> <li>Ir</li> <li>Ir</li> </ul>	emonstration of pre- emonstration of A gorithm emonstration of clas gorithm emonstration of clas emonstration of clas gorithm emonstration of clus emonstration of clus emonstration of clus emonstration of clus emonstration of clus emonstration of clus emonstration of secon plementation of Secon plementation of Secon plementation of Secon	processing on different da ssociation rule process assification rule process sification rule process on ssification rule process on stering rule process on diff atering rule process on diff atering rule process on diff atering rule process on diff stering rule process on diff stering rule process on diff atering rule process on diff	on d on d diffe n diff ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent ferent	differ differ rent of ferent t data t data t data t data t data t data t data t data	rent datase t data set u set u set u set u set u set u set u set u set u	data latas et us aset sing sing sing using using using	aset using set using sing id3 a using na g simple l g simple l g DBSCA g simple nce data s data set.	ng apriori FP Tree algorithm iive bayes c-means c-mediods c-mode. N. Hieratical set.	24
Text Book: ➤ T. Se 2007. References: ➤ M. Ha Softw	garan, all, E. vare: A	Programming Colle Frank, G. Holmes, H An Update, ACM SI	B. Pfahringer, P. Reuteman GKDD Explorations New	g Sm nn, & slette	art W z I. H er, Vo	Veb 2	2.0 A	Application The WE	ons, O'Rei EKA Data 2009.	lly, Mining

Course No:	No: 22 Course Name: Econometrics Course Code: MMAE 0117								0117	
Batch:		Programme: M.Sc.	Semester:	L	Т	Р	J	Credits	Contact Hrs Per Week:4	
2024-2026		Mathematics	III/IV	3	0	2	0	4	Total Hours: 4	0
Total Evalu	ation	<b>Marks:</b> 100	Examinatio	on D	uratio	n: Mid	l Term	(2 hours),	End Term (3 hou	ırs)
Theory Ass Internal As	sessme sessm	ent: 75 Marks ent: 25 Marks	Pre-requisi	ite of	cours	e: Reg	gressio	n Analysis a	and Predictive Mo	odelling
Course Objective	This econo throu statis skill o	course will developmic phenomen gh SURE and tical models wi development ali	elop a profou a. The stude Panel-Data ll be develop gned with al	und u nts w moo ped in 1 CO ³	ndersta vill lear dels. F n this o 's.	n the c further, course.	of app concept a de This c	lying statist t of modelin ep understa course focu	ical inference to ng real-life data p anding of estima ses on employabi	quantity roblems ation of ility and
Course Outcomes	After CO1 CO2 CO3 CO4	<ul> <li>After studying these topics, the students will be able to:</li> <li>CO1: Apply statistical inference to quantity economic phenomena.</li> <li>CO2: Model real-life data problems through SURE and Panel-Data models.</li> <li>CO3: Estimate statistical models in which the dependent variables are functio variables (SEM).</li> <li>CO4: Understand the difference between casuality quarrelation cointegration multivariate time series to real data.</li> </ul>								of other d apply
		multivariate tir	ne series to r	real d	ata. 5 SVI	LARI	S			
Module No						ent				Hours
	[Con	rse Outcome(s)	No.: 1 and	21	cont					Hours
I	Mode varia mode Probl	els with dumn ble, LOGIT, PR els. em of multicoll ators	interview of the openation of the openat	ent IT an seque	variabl d mult ences a	es and inomial nd solu	l discr l choic ntions,	rete and line e models, P ridge regres	mited dependent oisson regression ssion and LASSO	20
	Seem mode Simu probl	lingly unrelated els: estimation ir ltaneous equati em of identifica	regression en random effe ons model, tion, rank an	equati ect ar exam d ord	on (SU nd fixed ples, c ler con	JRE) m d effect concept ditions	nodel a model t of str of ider	nd its estim ls. ructural and ntifiability.	nation, Panel data d reduced forms,	
п	[Cou Meth stage estim estim Multi	ods of estimati least squares a ator, idea of th ation, prediction	s) No.: 3 and on in simult and limited in ree stage lead and simultaties processed	d 4] taneo inforn ast sq aneou es anc	us equ nation uares a us confi 1 their	ations maxin and ful dence proper	model num li l infor interva ties, V	, indirect le kelihood es mation max ls. ector autor	east squares, two timation, k class timum likelihood egressive (VAR),	20
	vecto proce Gran, causa test. Coint and c	a moving avera esses. ger causality, in al relations in bi- tegration, Grang ointegration tes	ge (VMA) a istantaneous variate mod ger representa t in static mod	Gran Gran els, C ation odel.	nger ca Grange theore	utoregi usality r causa m (with	and f lity tes	roof), Bivar	naracterization of Pierce test, Hsiao iate cointegration	

- > P. G. Apte, Text books of Econometrics, Tata McGraw Hill, 1990.
- > D. Gujarathi, Basic Econometrics, McGraw Hill, 1979.
- > J. Johnston, Econometric methods, Third edition, McGraw Hill, 1984.
- G. G. Judge, W. E. Griffiths, R. C. H. Lütkepohl & T. C. Lee, The Theory and Practice of Econometrics, Wiley, 1985.

- A. Koutsoyiannis, Theory of Econometrics, Macmillan Press, 1979.
- V. K. Srivastava & D.A.E. Giles, Seemingly Unrelated Regression Equations Models, Marcel Dekker, 1987.
- A. Ullah & H. D. Vinod, Recent Advances in Regression Methods, Marcel Dekker, 1981.

Course No: 2	23 Course Name	S	Course Code: MMAE 0118							
Batch:	Programme: M.Sc.	Semester:	L	Т	Р	J	Credits	Contact Hrs Per Week:4		
2024-2026	Mathematics	III/IV	3	0	2	0	4	Total Hours: 4	0	
Total Evalua	tion Marks: 100	Examinatio	on Di	iratio	n: Mid	Term	(2 hours), l	End Term (3 hour	rs)	
Theory Asse Internal Ass	essment: 75 Marks sessment: 25 Marks	Pre-requisi	ite of	cours	e: Nil					
Course Objective	This course will dev real-life data probl models for investiga framing models for employability and sk	elop a profou ems. The st ting the associ recurrent even till developme	und und udent ciation ents v ent al	ndersta s will n betw vill be	anding of learn een the develo with all	of surv the for variat ped in CO's.	rival analys rmulation o bles. Further this course	is and its applica f the propotional , a deep understate e. This course foo	tions to l liazard nding of cuses on	
Course Outcomes	<ul> <li>After studying these topics, the students will be able to:</li> <li>CO1: Understand the underlying concepts of survival analysis and apply it to real-life day problems.</li> <li>CO2: Analyze data in which the time until the event is of interest.</li> <li>CO3: Use the basic idea of censering in survival analysis and apply the methods accordingly.</li> <li>CO4: Formulate the proportional hazard models for investigating the association between the variables.</li> <li>CO5: Frame models for recurrent events.</li> </ul>								life data ngly. veen the	
		COU	JRSI	E SYL	LABU	S				
Module No.				Cont	ent				Hours	
I	[Course Outcome(s Survival Analysis-I their inter-relationsh truncation, Uses of I Log–Rank Statistic f Parametric Surviv models.Estimation a	) No.: 1, 2 an ntroduction, ips. Various Life table, Ka or Several Ga al Models- nd testing pro-	d 3] Outlin prope aplan- coups Expo ocedu	nes an erties o -Meies nential res on	d objec of hazar r Surviv , Weib these m	tives, A d func val Cur ull, G odels,	Application tion. Types rves and the amma, Nor	s.Basic terms and of censoring and e Log–Rank Test, mal, Log-normal	20	
П	[Course Outcome( Proportional Hazar its Characteristics. Hazards Model (Tim Recurrent Event S Risks Survival Analy	s) No.: 4 and rd Models- A The Stratifience-Dependent urvival Anal ysis-Competin	<b>d 5]</b> Assund Co ). I <b>ysis-</b> ng ris	nption, x Proc Introc k even	the Co cedure.I luction, ts and I	ox Prop Extensi outlin Frailty	portional Ha on of the e and objec models.	azards Model and Cox Proportional ctives, Competing	20	
Text Books: → P. D. → D. G. → J. P. H Sprin	Allison, Survival An Kleinbaum & M. Kl Klein & M. L. Moesc ger Verlag, 2005.	alysis Using ein, Survival hberger, Surv	SAS: Analy	A Prac ysis: A Analys	ctical G Self-L is–Tecl	uide, S earning nniques	SAS Institute g Text, Spri s for Censor	e, 2010. nger-Verlag, 2012 red and Truncated	2. Data,	

- > D. W. Hosmer, & S. Lemeshow, Applied Survival Analysis: Regression Modeling of Time to Event Data, Wiley-Interscience, 2008.
  M. Cleves, W. Gould, & R. Gutierrez, An introduction to survival analysis using STATA, Stata Press,
- 2010.

Course No:	Ourse No: 24       Course Name: Discrete Mathematics       Course Code: MMAE 0009									
Batch:		Programme: M.Sc.	Semester:	L	Т	Р	J	Credits	Contact Hrs Per Week: 4	
2024-2026		Mathematics	III / IV	4	0	0	0	4	Total Hours:40	)
Total Evalu	ation N	<b>Jarks:</b> 100	Examinatio	on Du	iration	: Mid	Term	(2 hours),	End Term (3 hour	rs)
Theory Ass	sessme	<b>nt</b> : 75 Marks	Pre-requisi	te of	course	• Nil				
Internal As	ssessm	ent: 25 Marks	i i e-i equisi		course	• 111				
Course	This o	course will dev	elop a profo	und	understa	anding	of pa	rtially orde	red sets, lattices,	Boolean
Objective	algebi	ra and their ap	plications. F	urthe	r, a dee	ep und	lerstan	ding of sp	ectra of finite gra	phs and
	regula	ar graphs, Cayl	ey graphs ai	nd Ra	amanuja	n graj	phs wi	ill be deve	loped in this cour	se. This
	course focuses on employability and skill development aligned with all CO's.									
	After	studying these	topics, the stu	ıdent	s will b	e able	to:			
Course	CO1:	Understand pa	rtially ordere	d sets	s, lattice	s, thei	r types	and lattice	homomorphism.	
Outcomes	<b>CO2</b> :	Learn projectiv	ve Intervals, S	Schre	ier's Re	efinem	ent Th	eorem and	isomorphism theor	rem of
Outcomes		moduler lattice	s.						-	
	<b>CO3</b> :	Apply the De I	Morgan Form	nulae	with ex	ample	s.			
	<b>CO4</b> :	Use the concep	ots of Boolean	n alge	ebra and	l truth	table.			
	<b>CO5</b> :	Understand the	e concepts of	spect	ra of gr	aphs a	nd app	olication of	spectra.	
	<b>CO6</b> :	Calculate the e	nergies of di	fferer	t types	of gra	phs.		1	
			COU	JRSI	E SYLI	LABU	S			
Module					Conte	nt				Hours
No.										
	[Cour	se Outcome(s)	) No.: 1, 2 ai	nd 3]						
	Lattic	e <b>Theory</b> : Part	ially ordered	sets.	Diagra	ams, L	Lower	and Upper	Bounds, Lattices,	
	The lat	ttices theoretica	d duality prin	nciple	, Semi	lattice	s, Latt	ices as part	tially ordered sets,	
Ι	Diagra	ms of lattices,	Sub lattices	, Lati	tice hor	nomor	phism	, Axiom sy	stems of lattices,	20
	Compl	ete lattices, Dis	tributive latti	ices, I	Modula	r lattic	es, Ch	aracterizati	on of modular and	
	distrib	utive lattices,	Similar in	terval	ls, Pro	jective	e inte	rvals, Zes	senhau's lemma,	
	Schrei	er's refinement	t theorem, l	ndep	endent	sets v	with p	properties,	The isomorphism	
	theorem	n of modular la	ttices.	-			-	•	-	
	Boolea	n Algebra I: I	De Morgan fo	ormul	ae, Con	nplete	boolea	an algebras.	Boolean algebras	
	and bo	olean rings, T	he algebra o	of rel	ations,	Boole	an hoi	momorphis	m, Representation	
	theorei	n.	C		,			1	, I	
	[Cour	se Outcome(s)	) No.: 4, 5 ai	nd 6]						
	- Boolea	n Algebra II:	Boolean exr	ressi	on. Alg	orithm	n for fi	nding sum	-of-products form.	
	Minim	al sum-of-prod	ucts. Consen	sus o	f funda	mental	l produ	icts. Algori	thm. Logic. Gates	
п	and Ci	rcuits. Boolean	functions and	d its t	ruth tab	le.	- prode		, 20810, 00000	20
	Spectra	a of finite grap	hs. Characte	ristic	polvno	mials.	Spect	ra. Spectra	of $K_n$ . $C_n$ and $P_n$ .	
	Bound	s of spectra. Th	ne spectra of	regul	ar gran	hs. Th	e spec	trum of the	e complement of a	
	regular	graph. Spectra	of line graph	ns of	regular.	Spect	rum of	f the comple	ete Bipartite graph	
	$K_{n:a}$	Cavley graphs.	Unitary Cavl	ev gr	aphs sr	ectrun	n of th	e Cavley g	raph Xn. Strongly	
	regular	graphs. Rama	nuian graph	s. En	ergy of	a gra	ph. M	aximum er	nergy of k-regular	
	graphs	Energy of Cay	vley graphs.	- 1	8,	0	<b>T</b> '		0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0	
Text Book:	<u>, 1</u>	, <u> </u>	7.8 · T							I
> N. Ja	acobsor	: Lectures in A	bstract Algel	ora: B	asic Co	oncepts	s, Sprii	nger-Verlag	g, 2012.	
Keference F	Sook:					D	10.02			
⊨ ≻ G. S	zasz, In	troduction to L	attice Theory	<i>i</i> , Aca		Press,	1963.			

## **SYLLABI OF SUBJECTS**

## **SKILL ENHANCEMENT ELECTIVE COURSES (SEC)**

Course No:	1 Course Name	: Programmi	ng in	Python	Cour	se Coo	de: MCAC	0016		
Batch:	Programme:	Semester:	L	Т	Р	J	Credits	Contact Hrs.		
	M.Sc.							Per Week: 3		
2024-2026	Mathematics	II	3	0	0	0	3	Total Hours: 3	6	
Total Evalua	ation Marks: 100	Examinatio	n D	ration	• Mid	Term	(2  hours)	Find Term (3 hou	rs)	
					• WIIU	ICIII	(2 110013), 1		15)	
Theory Asse	essment: 75 Marks	Pre-requisi	te of	course	: Nil					
Internal Ass	sessment: 25 Marks	-								
Course	This course introduce	es the solving	of n	nathema	tical p	roblen	ns using Pyt	hon programming	g using	
Objective	OO concepts and its	connectivity	with	database	e. This	cours	e focuses or	employability ar	nd skill	
	development aligned	with all CO'	s.							
Course	After studying these topics, the students will be able to:									
Outcomes	CO1: Understand the basics of Python Programming.									
	<b>CO2:</b> Apply the concepts of control structures and string manipulations of python programming.									
	CO3: Understand the	e use of data	struct	ures ava	ailable	in Pyt	honList, Tu	ple and Dictionar	y.	
	<b>CO4:</b> Experiment user-defined functions and access built-in functions.									
	time data time	er-defined m	odule	es and ad	cess t	Junt-In	i modules- n	hath, random, stri	ng, date	
	<b>CO6</b> . Develop the pr	ograms using	r the	concent	of Fil	e Hana	lling			
	CO7: Develop progr	ams based or	i Exc	entional	Hand	ling	unig.			
	eon bevelop progr		IRSI	E SYLI		S				
Module No.				Conte	nt	0			Hours	
	[Course Outcome(s)	No.: 1. 2. 3	and	41						
	Introduction to Py	<b>thon:</b> Intro	ducti	on and	Basi	cs; Se	tting up pa	ath Python Data	a	
	Variables & Operato	rs: Data Vari	ables	and its	types	, id () a	and type ()	functions, Coding	7	
I	Standards;				• •	Ū	•••		18	
	<b>Control Structures:</b>	if-else, elif,	Neste	ed if, Ite	ration	Contro	ol structures	, Break, Continue		
	& Pass;									
	String Manipulation	n: Accessing	Strii	ngs, Bas	sic Op	eration	ns, String sli	ces Function and	1	
	Methods.			~ · ·				<b></b>		
	Lists: Introduction,	accessing I	ist, (	Operatio	ons, V	Vorkin	g with list	s, Function and	1	
	Wiethods.	oooosing tur		Onorati	and W	ortino	Eurotions	and Mathada		
	Dictionaries: Introdu	accessing tup	sing	values i	n dicti	onarie	s Working	with dictionaries		
	Properties Functions	ietion, acces	sing	values 1		onane	s, working	with dictionaries	,	
	Functions: Defining	& Calling a	funct	ion. Pas	sing a	rgume	nts to functi	ons –		
	Mutable & Immutab	le Data Type	es. D	ifferent	types	of arg	uments, Re	cursion, scope of	f	
	variables.	21	,		21	U	, ,	, <b>1</b>		
II	[Course Outcome(s)	No.: 5, 6 an	d 7]							
	Modules and Packa	ges: User-de	fined	module	s and	Standa	rd Library:	random, numpy,		
	sys, Math Module, St	ring Module	, List	Module	e, Date	e & Tir	me Module,	Regular		
	Expressions: match, s	search, replac	e; In	troducti	on to ]	PIP, In	stalling Pac	kages via PIP		
	Input-Output: Print	ing on screen	, read	ding dat	a from	i keybo	oard, Openir	ng and		
	Closing file, Reading	and writing	files,	Functio	ons.			0 (* 11 1	18	
	Exception Handling	: Exception,	Exce	ption H	andlin	g, exce	ept clause, ti	ry? finally clause,	,	
	User Defined Except	ions.	mag	Pr Dutho	n main	a Dond				
	Object Oriented Pr	and data man	Crea	ting Cls		g Fallu Instanc	ias. ve Variables	& Access		
	Specifiers Methods	& Complete l	Pytho	n Progr	am In	nnortai	nce of self	init ()		
	method. Instance Me	$\sim$ complete 1 thods.	June		, 11	Porta		()		
Text Book:	nie urou, instance me								I	
	rry Hand First Dutha	1. A Brain E.	ion di	v Guida	סיח		(edia 2010			
F. Da	iry, neau riist rythol	i. A diaiii-fi	iciidi	y Guide	, 0 к		icula, 2010.			
<b>Reference</b> B	ook:									

> B. Slatkin, Effective Python: 59 Specific Ways to Write Better Python, Addison Wesley, 2015.

Course No:	<b>Course Name:</b> Python Programming Lab <b>Course Code:</b> MCAC 0810												
Batch:	Programme: M.Sc.Semester: ILTPJCreditContact Hrs. Per Week: 2								Contact Hrs. Per Week: 2				
2024-2026		Mathematics	II	0	0	1	0	1	Total Hours: 2	4			
Total Evalua	ation 1	Marks: 100	Examinatio	Examination Duration: End Term (2 hours)									
Internal: 50 External: 40 Attendance	) Mark 0 Mari : 10 N	ts ks Iarks	Pre-requisite of course: Nil										
Course Objective	This of and it aligned	course introduce s connectivity v ed with all CO's	s the solving vith database	g of pr 2. This	coblems	using I focuse:	Python s on en	programm nployabilit	ning using OO con y and skill develo	acepts			
Course Outcomes	After CO1: CO2: CO3:	COUDEE SYLLADUE											
			COU	URSE	E SYLL	ABUS	)						
Module No.					Conten	it				Hours			
Ι	• Progr Progr Usag	Obtaining use Printing desin ams based on th Conditional i Nested if stat Using else if ams based on th e of Data Struct Strings Lists Tuples	er Data ed output le concepts o f statements ements and elif le concepts o ures	of: of Itera	ation usi	ng diff	erent k	inds of loc	ops	24			
	• • Progr	Sets Dictionary ams related to (	Object Orient	ted Co	oncepts:								
	Creat Impo defau	ing Classes, I rtance of self, lt parameters in	nstance Vai init () Methods.	riables methe	s, Acces od, Clas	ss Spo ss Met	ecifiers hods a	s, User d and Static	efined Methods, Methods, Using	, r >			
	Hand • •	ling Database C Inserting and Use of Stored Invoking stor	Connectivity v Retrieving I I Procedures red functions	with P Data	'ython:								
Text Book: ≻ P. Ba	arry, H	ead First Pythor	n: A Brain-Fi	riendl	y Guide,	O'Re	illy Me	edia, 2010.					
Reference B ➤ B. SI	ook: atkin.	Effective Pytho	n: 59 Specifi	c Way	vs to Wr	ite Bet	ter Pvt	hon, Addis	son Wesley, 2015				

Course No:	3 Course Name: Ap	Name: Application of MS ExcelCourse Code: BBAK 2804									
Batch:	Programme: B. So	c. Mathematics-DS and	Semester:	L	T P	J	Credit	s Contact I Per Wee	Hrs ek: 3		
2023-2027	M.S	c. Mathematics	III	2	0 2	0	3	Total Ho	ours: 40		
Total Evalue	tion Marks: 100	Examination Duration: Mid Term (2 hours), End Term (3 hours)									
	<b>11011 14141 KS.</b> 100	Pre-requisite of	Pre-requisite of course: Basic knowledge of computers and								
Theory Asso Internal Ass	essment: 75 Marks sessment: 25 Marks	familiarity with recommended. Pr concepts and analy with the course ma	MS-Office ior underst tical skills v terial.	app and vill	olicatio ing o be ber	ons, of f nefic	especia undame ial for et	Illy MS-E ntal math ffectively e	xcel, is ematical engaging		
	<ul> <li>Equip students with</li> </ul>	n practical knowledg	ge of MS Ex	kcel	for b	usine	ess anal	ytics and d	lecision-		
	making.	hensive understand	ing of dat	9 A	ntry	forn	natting	and visu	alization		
	techniques in Excel		ing of data	u c	iiti y,	10111	iatting,		anzation		
Course	Develop proficiency	in advanced Excel	functions and	d fo	rmula	s for	efficien	t data analy	ysis.		
Objective	Enable students to c	reate and interpret co	omplex sprea	adsh date	neet m	odel	s for bus	siness scena	arios.		
	automation using m	acros and VBA.		uata	a man	ipuiz	uion, cu		ing, and		
	After studying these to	pics, the students wil	ll be able to:								
Course	<b>CO1:</b> Utilize basic and	d advanced Excel fu	inctions and	for	mulas	for	effective	e data anal	ysis and		
Outcomes	CO2: Apply data visua	lization techniques t	o create and	inte	ernret	char	s and or	aphs			
	CO3: Implement adva	anced features such	as PivotTal	bles	, Mac	ros,	and Wl	hat-If Anal	lysis for		
	complex data sc	enarios.									
	<b>CO4:</b> Integrate and an	alyze data from vari	ous sources	to s	uppor	t bus	siness de	ecision-mal	king and		
	Toporting.	COURSE SY	LLABUS								
Module No.		Co	ntent						Hours		
	[Course Outcome(s) N	No.: 1 and 2]					f anno a	dahaata in			
I	business analytics, exp customization options, and addressing, applica font formatting options formatting rules for da data cleaning, arithme	loration of Microsoft spreadsheet compo- ation of spreadsheets s, cell alignment and ta visualization, cre etic operators and functions: SUM	t Excel and ( nents (cells, in business merging ce ating heat m basic form	Goo row ana ells, naps ulas,	portain ogle Sh vs, col alytics forma , colo , abso	umn dat dat utting r sca olute	, user in s), cell r a entry t g tools, c iles, and and re	terface and referencing techniques, conditional data bars, stative cell	20		
	references, common functions: SUM, AVERAGE, COUNT, IF and VLOOKUP functions, nested formulas, debugging and troubleshooting formula errors, advanced functions and logical operations: IF-ELSE, AND, OR, LEFT, RIGHT, MID, SUBSTITUTE, REPLACE, COUNTA, CEIL, FLOOR, IFS, MAXIF, MAXIFS, MINIF, MINIFS, SUMIF, SUMIFS, AVERAGEIF, AVERAGEIFS, COUNTIF, COUNTIFS, INDEX, MATCH, OFFSET, VLOOKUP, HLOOKUP, XLOOKUP, FILTER, and advanced filter.										
II	COUNTIES, INDEX, MATCH, OFFSET, VLOOKUP, HLOOKUP, XLOOKUP, FILTER, and advanced filter.[Course Outcome(s) No.: 3 and 4] Creating bar, line, and pie charts, adding trendlines, data labels, and error bars, customizing chart elements for visual impact, PivotTables and Pivot Charts, advanced formulas, array formulas, data validation and protection, Goal Seek, What-If Analysis, Data Analysis ToolPack, IFERROR, custom and dynamic charts, data import from various sources, Flash Fill, Macro, VBA, building decision models, integration of external data sources, slicers and timelines, dashboard creation, custom formatting, conditional formatting, date functions, and										

- M. Alexander, R. Kusleika and J. Walkenbach, Excel 2019 Bible, Wiley, 2018.
- > P. Gupta, Microsoft Excel 2019: The Ultimate Guide, BPB Publications

- K. N. Berk and P. Carey, Data Analysis with Microsoft Excel, Duxbury Press, 2009.
- Excel for Business Mathematics" by Shailendra Kadre

## **SYLLABI OF SUBJECTS**

## ABILITY ENHANCEMENT COMPULSORY COURSES (AECC)

Course No:	1	Course Name	: Technical V	ng	Course Code: MELH 0006								
Batch:		Programme: M.Sc.	Semester:	L	Т	Р	J	Credits	Contact Hrs Per Week: 4				
2024-2026		Mathematics	II	4	0	0	0	4	Total Hours: 4	0			
Total Evalua	ation 1	Marks: 100	Examinatio	Examination Duration: Mid Term (2 hours), End Term (3 hours)									
Theory Ass Internal As	essme sessm	nt: 75 Marks ent: 25 Marks	Pre-requisi	Pre-requisite of course: Nil									
Course Objective	The mode	objective of th es of written c	is course is ommunication	to n on us	nake the sed to o	ie stud dissen	lents ι ninate	understand information	the concepts of n within and out	various tside an			
a	orgar	nization. This co	ourse focuses	on e	mploya	bility a	nd ski	ll developm	ent aligned with a	ll CO's.			
Course	After studying these topics, the students will be able to:												
	CO2: Learn writing skills to write technical reports, formal messages and letters. CO3: Know the writing of technical proposals, research papers, dissertation reports etc. CO4: Make curriculum vitae, resume and agenda and minutes of a meeting. COURSE SYLLABUS												
Module No.					Conte	nt				Hours			
I	ItomContentItoms[Course Outcome(s) No.: 1 and 2]Forms & features of communication factors facilitating communication-communication channels, Flow of communication, Language skills-LSRW, Barriers to communication, Words and Phrases, Sentences and Paragraphs, Art of condensation reading comprehension, Analyzing audience, Organizing contents, Preparing an outline, Visual Aids paragraph writing: characteristics and methods Technical reports, Importance, Preparatory steps and Structure letters Memos and E-mails- structure Principles Types									18			
Π	<ul> <li>II [Course Outcome(s) No.: 3 and 4] Technical proposals- Definition, Types, Structure and Style. Journal articles/ Research papers- Nature, Significance and essentials. Job Application- Resume, Curriculum Vitae and Cover letter. Interviews-Types, Preparation, Success and Failure Factors. Agenda and minutes of a meeting. Note making &amp; summarizing Dissertation and Thesis- Definition, Characteristics Style and Presentation. Preparing List of References and Bibliography: Referencing Conventions.</li> </ul>								18				
Text Book: R. M Press	eenaks , New	shi & S. Sharma Delhi, 2015.	a, Technical (	Comn	nunicati	on: Pr	inciple	s and Practi	ce, Oxford Unive	rsity			

- > M. A. Rizvi, Effective Technical Communication, New Delhi, Tata McGraw Hill, 2005.
- R. C. Sharma & K. Mohan, Business Correspondence and Report Writing, Tata McGraw Hill, New Delhi, 2002.

## **SYLLABI OF SUBJECTS**

# HUMANITIES AND SOCIAL SCIENCES COURSES (HSSC)

Course No:	1	Course Name: Soft Sk	ills-I			Cour	se Co	de: BSDH	H 0301			
Batch:		<b>Programme:</b> B. Sc. Mathematics-DS	Semester: III/I	L	Т	Р	J	Credits	Contact H Per Weel	Irs x: 3		
2023-2027		and M Sc. Mathematics		3	0	0	0	3	Total Ho	urs: 40		
Total Evalu	ation I	Marks: 100	Examinatio	l n Dur	ation:							
I otur L varu		<b>Hullis:</b> 100	Mid Term (2 hours), End Term (3 hours)									
Theory Ass	essme	nt: 75 Marks	Due requisite of courses Nil									
Internal As	sessm	ent: 25 Marks	Pre-requisit	e of c	ourse:	Nil						
Course	The f	focus is on the English	grammar erro	r corr	rection	algori	ithm v	which is an	important	task of		
Objective	natura	al language processing t	hat encourage	es stu	dents t	o reco	ognize	and corre	ct various	possible		
	synta	ctical, lexical, grammatic	al, and punctu	ation	errors	often	commi	tted by a n	on-native l	anguage		
	learne	er. The objective is to e	ase the comp	lexity	of gra	mmar	rules,	ambiguity	y of seman	tics and		
	ambig	guity of grammar. The	students must	t have	e the a	bility	to use	e a wide 1	ange of a	lgebraic		
	geom	geometric, and statistical tools which are required in many fields of postsecondary education so										
	the st	the students gain appropriate skills to succeed in preliminary selection process for recruitment.										
	After	studying these topics, the	students will	be ab	le to:							
Course	CO1:	: Juxtapose the previously	y-learned basi	cs of t	the grau	nmar	with th	ne recently	acquired			
Outcomes		intermediate skills of a s	student, specif	fically	at a set	ntence	e level,	to augmen	t the know	-how of		
Outcomes		the usage of the language	e in a variety	of stru	ictures							
	CO ₂ :	: Jettison the confusion a	nd complexity	/ from	the mi	nds of	the st	udents as fa	ar as the rul	les of		
		the language are concern	ned.									
	CO3	: Juggernaut the students	to the mastery	y of a	myriad	of ma	thema	tical modu	les, majorly	y		
		algebra, geometry, and s	statistics.									
			COURSE SY	<b>ZLLA</b>	BUS							
Module No	•		Со	ntent						Hours		
	[Cou	rse Outcome(s) No.: 1,	2 and 3]									
	QUA	NTITATIVE APTITUE	<b>DE AND LOC</b>	GICAI	L REA	SONI	NG					
	PURI	<u>E ARITHMETIC-II</u> : A1	rithmetic Pro	gressi	on, G	eomet	ric Pr	ogression,	Harmonic	,		
	Progr	ession, Functions.				_		_				
	COM	ERCIAL ARITHMETIC	<u>-II</u> : Clocks, C	alenda	ar, Rati	o Prop	ortion	-I.				
I	VER	BAL ABILITY								20		
	VOC	ABULARY ENRICHME	2 <u>NT</u> : Synonyn	T: Synonyms, Antonyms, Odd Words. Idioms and Phrasal								
	Verbs	s. Same Words –Different	Parts of Spee	ech.								
	VER	<u>BAL REASONING</u> : W	ord Analogy	, Sei	ntence	Corre	ection	&Text C	Completion,	,		
	Sente	nce Equivalence.										
	[Cou	rse Outcome(s) No.: 1,	2 and 3]									
	QUA	NTITATIVE APTITUE	<b>DE AND LOC</b>	GICAI	L REA	SONI	NG					
	COM	MERCIAL ARITHMET	<u>IC-II</u> : Ratio I	Propoi	rtion-II	, Mixt	ures &	Solutions,	Average.			
II	DIRE	ECTION SENSE: Cardi	nal direction	s, int	er care	dinal	directi	ons, comp	pass based	20		
	probl	ems, shadow based proble	ems.									
	COMMERCIAL ARITHMETIC-III: Time speed and Distance, Races, Problems on Trains,											
	Boat	and Stream, Time and Wo	ork, Pipe and o	cisterr	1.							
	VER	BAL ABILITY:		C .			•					
Tart Darlar	EKK	<u>DR ANALYSIS:</u> Identific	ation of Error	s, Sen	tence C	orrect	10n.					
Text Books:		How to manage for Our	titative Antite	da fa		TN /11	anh li	ation 202	4			
$\rightarrow$ A. S.	Dond	now to prepare for Quan	BSo Publish	ing Co	$\Delta D v t l$		public	ation, 2024	+.			
IVI. N Reference D	s. rano	ey, Anaryucai Keasoning			). F VI. I	_iu, ∠(	JU7.					
	Δασαι	rwal Quantitative Antitud	e S Chand E	hlick	ning 70	)22						
Jaiki	shan a	nd Premkishan How to	Crack Test of	² Reas	oning i	n A11	Comr	etitive Exa	minations	Arihan		
Publ	ication	, 2018		1040	5		20mp	Lance Dat				

<b>Course No:</b>	2	Course Name: Soft Skills-II				Coi	urse	e Code:	BSDH 03	02	
Batch:		<b>Programme:</b> B. Sc. Mathematics-DS and	Semester: IV/II	L	Т	Р	J	Credits	Contact H Per Wee	<b>Irs</b> k: 3	
2023-2027		M.Sc. Mathematics		3	0	0	0	3	Total Ho	urs: 40	
Total Evalu	ation I	Marks: 100	Examinatio	on E	Jura	atio	n:				
			Mid Term (2	2 ho	urs),	, End	d Te	erm (3 hou	ırs)		
Theory Ass Internal As	essme sessm	nt: 75 Marks ent: 25 Marks	Pre-requisi	ite o	f co	ours	e: N	Vil			
Course	Hone	critical thinking skills by analyz	zing the arguments with explicit and implicit premises to								
Objective	throu	gh case studies on work ethic	s and organ	izati	iona	l he	ing ehav	vior Dev	elon and	evaluate	
o sjeen ve	infere	ences and predictions that are b	ased on data	; an	d se	elect	t an	d use app	propriate s	tatistica	
	metho	ods to analyze data; formulate	questions tha	t ca	n b	e ac	ddre	ssed with	data and	collect	
	organ	ize, and display relevant data to a	nswer all type	es of	que	estio	n in	any com	petitive exa	ams.	
	After	studying these topics, the student	s will be able	to:							
Course	CO1:	: Convert a student from a probl	em solver int	o a	thin	ker,	wh	o embarks	s on the jo	urney of	
Course		interpreting the data to come	to a cogent	cond	clusi	ion	base	ed on the	right assu	imptions	
Outcomes		derived from an argument									
	CO2:	: Converge the several quantitat	ive skills of	a sti	ıder	nt so	o tha	at she col	lects, com	pare and	
		conquers the complex data and	d conclude c	risp	infe	erend	ces	and interp	pretations f	from the	
		same.									
	CO3:	: Juggernaut the students to the	mastery of a	ı my	riad	l of	mat	hematical	l modules,	majorly	
	algebra, geometry, and statistics.										
		COURSE	E SYLLABU	JS							
Module No.	•		Content							Hours	
	[Cou	rse Outcome(s) No.: 1 and 2]									
	QUA	NTITATIVE APTITUDE AND	LOGICAL	REA	ASO	NIN	NG				
	GEO	METRY: Geometry –I Geo	metry-II, M	lens	ırati	ion	-I	, Mensu	ration II	,	
	Trigo DED	nometry-I, Trigonometry-II UCTIVE REASONING: Introduc	ction to Prima	ary S	State	emei	nts o	of logical	deduction.		
I	Unde	rstanding of different premises (li	ke ALL, SOM	ΛĒ,	SON	ЛЕÌ	NOT	Г, NO).		20	
	VER	BAL ABILITY:									
	PARA	<u>A JUMBLE</u> : Logical Rearrangeme	ent of Sentend	ces		_					
	CRIT	<u>ICAL REASONING-I</u> : Introd	uction to Di	iffer	ent	Par	ts o	of an Ar	gument in	L	
	Reaso	oning, Assumption of an Argume	ent, Strengthe	enin	g o	f an	Arg	gument,	Weakening	5	
	of an	Argument								<u> </u>	
		rse Outcome(s) No.: 1 and 2]	LOCICAL	пт							
		EDN MATHEMATICS. Data		кЕА , т	ч20 ПС1		NG c	fficianar	II Data		
TT	Interr	<u>PERN MATHEMATICS</u> : Data	Data Interpret	/ I,	л пШ	rata	Su	Inclency	II, Data	20	
11	VFR	<b>BAL ARILITY</b> .		latio	11 111	L				20	
	CRIT	ICAL REASONING-II: Recar	of Critica	1 R	easo	onin	σ	Strategies	Drawing	F	
	concl	usion of an Argument. Inference	of an Argume	ent.	Sun	nma	rizir	ng and Ev	aluation of		
	an Ar	gument.		,				-8			
Text Books:										•	
$\succ$	A. Sha	arma, How to prepare for Quantita	tive Aptitude	for	CA	Г, Т	MH	publicati	on, 2024.		
$\checkmark$	Jaikish	nan and Premkishan, How to Cra	ick Test of R	easo	onin	g in	All	Competi	tive Exam	inations	
	Arihar	t Publication, 2018									
	M. K.	Pandey, Analytical Reasoning, BS	Sc Publishing	Co.	Pvt	. Lto	d, 20	)09.			
Keference B	ooks:			1:-1.		<u>-</u>	า				
	K. S. A	Aggarwai, Quantitative Aptitude, S	S. Chand Pub	11Sh1	ng,	202. 	2.	Dubl:	ion 2020		
	A. Cho V. Sax	suchary and B. Patodi, verbal Ab kena and V. Bhatia, Crack WAT/C	BD/PI for MB	A A	dmi	л, L Issio	nsn	a Publicat Disha Pub	blication, 2020.	016.	

Course No: 3Course Name: Environmental StudiesCourse Code: BCHS								0201				
Batch:		Programme: M.Sc. Mathematics	Semester:	L	Т	Р	J	Credits	Contact H Per Weel	Hrs k: 2		
2024-2026			IV	2	0	0	0	2	Total Ho	urs: 28		
Total Evalu	ation	<b>Marks:</b> 100	Examination Duration: Mid Term (2 hours), End Term (3 hours)									
Theory Ass Internal As	sessme ssessm	ent: 75 Marks ent: 25 Marks	Pre-requisite of course: Nil									
Course	То с	reate awareness towards	various environmental issues like global warming, urba									
Objective	pollu socie	tions, ozone layer deple ty.	tion etc; thei	r caus	ses and	l reme	edial s	teps for p	rotecting i	mpacted		
	After	studying these topics, the	e students will be able to:									
Course	<b>CO1</b>	: Understand the environ	mental issues	pertai	ning to	day-te	o-day l	iving.				
Outcomes	CO2: Gain awareness for the need of environmental education vis-à-vis education for development.								tion for su	stainable		
	CO3	: Understand ecological p	perspective an	d valu	e of er	iviron	ment,	biotic com	ponents, ec	cosystem		
	CO4	• Assess water quality star	ain, water cyc	le etc.	ers of	water	nuality	air nolluti	on nolluta	inte acid		
	CUT	rain, global climate chan	ige and green	nouse	gases.	water	quanty	, an ponun	ion, ponuta	ints, actu		
	CO5	: Identify variety of social	l issues associ	ated w	with env	vironn	nental	deterioratio	on involvin	g human		
		components such as pop	ulation, ethics	and u	ırban se	ettlem	ents.					
			COURSE SY	<b><i>ZLLA</i></b>	BUS					T		
Module No				ntent						Hours		
	[COU Basic	rse Outcome(s) No.: 1,	2 and 3 Studies Envi	ronme	ntal S	tudies	• Intr	oduction	Scone and	1		
	Impo	rtance Environment: C	oncent Natu	ral an	nd Ant	hrono	oenic	Environme	ont Natural			
	Envir	conment: Structure & I	Function of Atmosphere. Hydrosphere. Lithosphere and									
	Biost	where Ecology and Eco	osystem Det	finitio	ns Tv	nes (	Structu	re & Fu	nctions of	2		
Ι	Ecos	vstem. Natural Resource	es: Introduction	on. C	lassific	cation.	Conc	cept of Co	onservation	14		
	Prese	ent Status and related to W	ater Resource	es. For	est Res	source	s and M	Mineral Re	sources.	E .		
	Curr	ent Environmental Pr	oblems: Ene	ergv l	Resour	ces: 1	ntrodu	ction. Cla	ssification			
	Energ	gy Use Patterns, Energy	Crisis, Alter	native	Ener	gy Re	source	s Present	Status and	L		
	Majo	r Issues Related to Fossil	I Fuels, Hydro	belectr	icity, I	Nuclea	r Ener	gy, Solar I	Energy and	l		
	Biom	ass Energy. Effects of	Human Activ	ities of	on Env	vironn	nent: E	Effect of A	griculture	,		
	Hous	ing, Mining, Transportati	on and Indust	ries.					-			
	[Cou	rse Outcome(s) No.: 1,	2 and 3]									
	Envi	ronment Pollution: Cau	ses, Effects a	nd Co	ontrol o	of Air	Pollut	tion, Water	Pollution	,		
	Land	Pollution and Noise Po	llution Introd	uction	and M	Aanag	ement	of Solid V	Wastes and			
II	Haza	rdous Wastes Global E	nvironmental	Chall	enges:	Glob	al Wa	rming, Oz	one Layer	14		
	Deple	etion, Acid Rain, Urbaniz	ation, Overpo	pulatio	on and	Biodi	versity	Depletion				
	Envi	ronmental Protection:										
	Envir	conmental Protection: Ro	ole of Citizens	s, Rol	e of G	lovern	ment,	Initiatives	by NGOs	,		
	Contr	ribution of International	Agencies and	d Con	ventio	ns Ap	proach	nes to Env	ironmental	l		
	Prote	ction: Public Awaren	ess, Environ	menta	ıl Edu	ucatio	n, Er	vironment	al Ethics	,		
	Envir	conmental Laws and Env	ironmental Ec	conom	ics To	ols an	d Strat	tegies: Env	ironmental			
	Impa	ct Assessment, Ecologica	al Footprints a	and S	ustaina	ble D	evelop	ment Effor	rts towards	3		
	Envir	conmental Protection in In	ndia									

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