K. C. E. Society's
Moolji Jaitha College
An 'Autonomous College' Affiliated to
K.B.C. North Maharashtra University, Jalgaon.
NAAC Reaccredited Grade - A (CGPA : 3.15 - 3rd Cycle)
UGC honoured "College of Excellence" (2014-2019)
DST(FIST) Assisted College

KNOWLEDGE IS POWER
ESTD. 1945

के. सी. ई. सोसायटीचे
मूळजी जेठा महाविद्यालय
क.ब.चौ. उत्तर महाराष्ट्र विद्यापीठ, जळगाव संलग्नित
'स्वायत्त महाविद्यालय'
नॅकद्वारा पुनर्मानांकित श्रेणी – 'ए' (सी.जी.पी.ए. : ३.१५ – तिसरी फेरी)
विद्यापीठ अनुदान आयोगाद्वारा घोषित 'कॉलेज ऑफ एक्सलन्स' (२०१४-२०१९)
डी.एस.टी. (फीस्ट) अंतर्गत अर्थसहाय्य प्राप्त

Date :- 25/04/2025

NOTIFICATION

Sub :- CBCS Syllabi of B. Sc. in Mathematics (Sem. III & VI)

Ref. :- Decision of the Academic Council at its meeting held on 22/04/2025.

The Syllabi of B. Sc. in Mathematics (Third and Fourth Semesters) as per **NATIONAL EDUCATION POLICY – 2020 (2024 Pattern)** and approved by the Academic Council as referred above are hereby notified for implementation with effect from the academic year 2025-26.

Copy of the Syllabi Shall be downloaded from the College Website (www.kcesmjcollege.in)

Sd/-
Chairman,
Board of Studies

To :

1) The Head of the Dept., M. J. College, Jalgaon.
2) The office of the COE, M. J. College, Jalgaon.
3) The office of the Registrar, M. J. College, Jalgaon.

Near Samarth Colony, Jalgaon - 425 002. (Maharashtra, India) | Ph. : +91 257 - 2237363, 2234281 | e-mail : mjcollege@kces.in | Website : mjcollege.kces.in
समर्थ कॉलनी जवळ, जळगांव – ४२५ ००२. (महाराष्ट्र, भारत) । दूरध्वनी क्र. : +९१ २५७–२२३७३६३, २२३४२८१ । ई–मेलः mjcollege@kces.in । वेबसाईटः mjcollege.kces.in

Khandesh College Education Society's

Moolji Jaitha College, Jalgaon

An "Autonomous College"

Affiliated to

Kavayitri Bahinabai Chaudhari

North Maharashtra University, Jalgaon-425001

KNOWLEDGE IS POWER

ESTD. 1945

STRUCTURE AND SYLLABUS

B.Sc. Honours/Honours with Research (S.Y. B.Sc. Mathematics)

Under Choice Based Credit System (CBCS)

and

as per NEP-2020 Guidelines

[w.e.f. Academic Year: 2025-26]

Preface

The Moolji Jaitha College (Autonomous) has adopted a department-specific model as per the guidelines of UGC, NEP-2020 and the Government of Maharashtra. The Board of Studies in Mathematics of the college has prepared the syllabus for the second-year graduate of Mathematics. The syllabus cultivates theoretical knowledge and applications of different fields of Mathematics. The contents of the syllabus have been prepared to accommodate the fundamental aspects of various disciplines of Mathematics and to build the foundation for various applied sectors of Mathematics. The program will be enlightened the students with the advanced knowledge of Mathematics, which will help to enhance student's employability.

The overall curriculum of three/four year covers pure mathematics, applied mathematics and computational mathematics with programming. The syllabus is structured to cater the knowledge and skills required in the research field, Industrial Sector and Entrepreneurship etc.. The detailed syllabus of each paper is appended with a list of suggested readings.

Hence, Board of Studies in Mathematics in its meeting held on 22/03/2025 resolved to accept the revised syllabus for S. Y. B. Sc. (Mathematics) based on Choice Based Credit System (CBCS) of UGC, NEP-2020 and the Government of Maharashtra guidelines.

Program Outcomes (PO) for B.Sc. Program:

Program outcomes associated with a B.Sc. degree are as follows:

PO No.	PO
1	Graduates should have a comprehensive knowledge and understanding of the fundamental principles, theories and concepts in their chosen field of study.
2	Graduates should possess the necessary technical skills and competencies related to their discipline, including laboratory techniques and data analysis.
3	Graduates should be able to identify, analyze and solve complex problems using logical and critical thinking skills. They should be able to apply scientific methods and principles to investigate and find solutions of problem.
4	Graduates should be proficient in effectively communicating scientific information, both orally and in writing.
5	Graduates should have a basic foundation in research methods and be capable of designing and conducting scientific investigations.
6	Graduates should be able to work effectively as part of a team, demonstrating the ability to collaborate with others, respect diverse perspectives and contribute to group projects.
7	Graduates should recognize the importance of ongoing learning and professional development. They should be equipped with the skills and motivation to engage in continuous learning, adapt to new technologies and advancements in their field and stay updated with current research.

Programme Specific Outcome (PSO) for B.Sc. (Matheematics) Honours/Honours with Research:

After completion of this program, students are expected to learn/understand the:

PSO No.	PSO
1	Demonstrate the concepts involved in Real Analysis, Matrix Theory, Differential Equations, Algebra, Number Theory and Applied Mathematics.

2	Gain proficiency in mathematical techniques of both pure and applied mathematics and will be able to apply necessary mathematical methods to a scientific problem.
3	Acquire significant knowledge on various aspects related to Linear Algebra, Metric Spaces, Lattice Theory, Integral Transforms, Optimization Techniques and Partial Differential Equations.
4	Learn to work independently as well as a team to formulate appropriate mathematical methods.
5	Develope the ability to understand and use the morality and ethics related to scientific research.
6	Realize the scope of Mathematics and plan to continue their education as a Post-Graduate student of Mathematics and contribute to Mathematics through their research as a researcher.

Multiple Entry and Multiple Exit options:

The multiple entry and exit options with the award of UG certificate/ UG diploma/ or three-year degree depending upon the number of credits secured;

Levels	**Qualification Title**	**Credit Requirements**		**Semester**	**Year**
		Minimum	**Maximum**		
4.5	UG Certificate	40	44	2	1
5.0	UG Diploma	80	88	4	2
5.5	Three Year Bachelor's Degree	120	132	6	3
6.0	Bachelor's Degree- Honours **Or** Bachelor's Degree- Honours with Research	160	176	8	4

Credit distribution structure for Three/ Four year Honors/ Honors with Research Degree Programme with Multiple Entry and Exit

F.Y. B.Sc.

Year (Level)	**Sem**	**Subject-I (M-1)**	**Subject-II (M-2)**	**Subject-III (M-3)**	**Open Elective (OE)**	**VSC, SEC (VSEC)**	**AEC, VEC, IKS**	**CC, FP, CEP, OJT, RP**	**Cumulative Credits/Sem**	**Degree/ Cumulative Credit**
I (4.5)	I	DSC-1(2T) DSC-2(2P)	DSC-1(2T) DSC-2(2P)	DSC-1(2T) DSC-2(2P)	OE-1(2T)	---	AEC-1(2T) (Eng) VEC-1(2T) (ES) IKS(2T)	CC-1(2T)	22	**UG Certificate**
	II	DSC-3(2T) DSC-4(2P)	DSC-3(2T) DSC-4(2P)	DSC-3(2T) DSC-4(2P)	OE-2(2T) OE-3(2P)	---	AEC-2(2T) (Eng) VEC-2(2T) (CI)	CC-2(2T)	22	
	Cum. Cr.	**8**	**8**	**8**	**6**	**---**	**10**	**4**	**44**	
Exit option: Award of UG Certificate with 44 credits and an additional 4 credits core NSQF course/ Internship OR Continue with Major and Minor.										

S.Y. B.Sc.

Year (Level)	**Sem**	**Subject-I (M-1) Major***		**Subject-II (M-2) Minor #**	**Subject-III (M-3)**	**Open Elective (OE)**	**VSC, SEC (VSEC)**	**AEC, VEC, IKS**	**CC, FP, CEP, OJT/Int/RP**	**Cumulative Credits/Sem**	**Degree/ Cumulative Credit**
		Mandatory (DSC)	**Elective (DSE)**	**(MIN)**							
2 (5.0)	III	DSC-5(2T) DSC-6(2T) DSC-7(2P)	---	MIN-1(2T) MIN-2(2T) MIN-3(2P)	---	OE-4(2T)	SEC-1(2T)	AEC-3(2T) (MIL)	CC-3(2T) CEP(2)	22	**UG Diploma**
	IV	DSC-8(2T) DSC-9(2T) DSC-10(2P)	---	MIN-4(2T) MIN-5(2P)	---	OE-5(2T)	SEC-2(2T) SEC-2(2P)	AEC-4(2T) (MIL)	CC-4(2T) FP(2)	22	

	Cum. Cr.	**12**	**---**	**10**	**---**	**4**	**6**	**4**	**8**	**44**	
	Exit option: Award of UG Diploma in Major and Minor with 88 credits and an additional 4 credits core NSQF course/ Internship OR Continue with Major & Minor.										

***** Student must choose one subject as a Major subject out of M-1, M-2 and M-3 that he/she has chosen at First year

Student must choose one subject as a Minor subject out of M-1, M-2 and M-3 that he/she has chosen at First year (Minor must be other than Major)

۞ OJT/Internship/CEP should be completed in the summer vacation after 4th semester

T.Y. B.Sc.

Year (Level)	**Sem**	**Subject-I (M-1) Major**		**Subject-II (M-2) Minor**	**Subject-III (M-3)**	**Open Elective (OE)**	**VSC, SEC (VSEC)**	**AEC, VEC, IKS**	**CC, FP, CEP, OJT/Int/RP**	**Cumulative Credits/Sem**	**Degree/ Cumulative Credit**
		Mandatory (DSC)	**Elective (DSE)**	**(MIN)**							
3 (5.5)	V	DSC-11(2T) DSC-12(2T) DSC-13(2T) DSC-14(2P) DSC-15(2P)	DSE-1A/B (2T) DSE-2A/B (2P)	---	---	---	VSC-1(2T) VSC-2(2P)	---	OJT/Int (4)	22	**UG Degree**
	VI	DSC-16(2T) DSC-17(2T) DSC-18(2T) DSC-19(2T) DSC-20(2T) IKS DSC-21(2P) DSC-22(2P)	DSE-3A/B (2T) DSE-4A/B (2P)	---	---	---	VSC-3(2T) VSC-4(2P)	---	---	22	
	Cum. Cr.	**24**	**8**	**---**	**---**	**---**	**8**	**---**	**4**	**44**	
	Exit option: Award of UG Degree in Major with 132 credits OR Continue with Major and Minor										

Fourth Year B.Sc. (Honours)

Year (Level)	**Sem**	**Major Core Subjects**		**Research Methodology (RM)**	**VSC, SEC (VSEC)**	**OE**	**AEC, VEC, IKS**	**CC, FP, CEP, OJT/Int/RP**	**Cumulative Credits/Sem**	**Degree/ Cumulative Credit**
IV (6.0)	VII	DSC-23(4T) DSC-24(4T) DSC-25(4T) DSC-26(2P)	DSE-5A/B (2T) DSE-6A/B (2P)	RM(4T)	---	---	---	---	22	**UG Honours Degree**
	VIII	DSC-27(4T) DSC-28(4T) DSC-29(4T) DSC-30(2P)	DSE-7A/B (2T) DSE-8A/B (2P)	---	---	---	---	OJT/Int (4)	22	
	Cum. Cr.	**28**	**8**	**4**	**---**	**---**	**---**	**4**	**44**	
Four Year UG Honors Degree in Major and Minor with 176 credits										

Fourth Year B.Sc. (Honours with Research)

Year (Level)	**Sem**	**Major Core Subjects**		**Research Methodology (RM)**	**VSC, SEC (VSEC)**	**OE**	**AEC, VEC, IKS**	**CC, FP, CEP, OJT/Int/RP**	**Cumulative Credits/Sem**	**Degree/ Cumulative Credit**
IV (6.0)	VII	DSC-23(4T) DSC-24(4T) DSC-26(2P)	DSE-5A/B (2T) DSE-6A/B (2P)	RM(4T)	---	---	---	RP(4)	22	**UG Honours with Research Degree**
	VIII	DSC-27(4T) DSC-28(4T) DSC-30(2P)	DSE-7A/B (2T) DSE-8A/B (2P)	---	---	---	---	RP(8)	22	
	Cum. Cr.	**20**	**8**	**4**	**---**	**---**	**---**	**12**	**44**	
Four Year UG Honours with Research Degree in Major and Minor with 176 credits										

Sem- Semester, **DSC**- Department Specific Course, **DSE**- Department Specific Elective, **OE/GE**- Open/Generic elective, **VSC**- Vocational Skill Course, **SEC**- Skill Enhancement Course, **VSEC**- Vocation and Skill Enhancement Course, **AEC**- Ability Enhancement Course, **IKS**- Indian Knowledge System, **VEC**- Value Education Course, **T**- Theory, **P**- Practical, **CC**-Co-curricular **RM**- Research Methodology, **OJT**- On Job Training, **FP**- Field Project, **Int**- Internship, **RP**- Research Project, **CEP**- Community Extension Programme, **ENG**- English, **CI**- Constitution of India, **MIL**- Modern Indian Laguage

- Number in bracket indicate credit
- The courses which do not have practical 'P' will be treated as theory 'T'

- If student select subject other than faculty in the subjects M-1, M-2 and M-3, then that subject will be treated as Minor subject, and cannot be selected as Major at second year.

Details of S.Y. B.Sc. (Mathematics)

Course	Course Type	Course Code	Course Title	Credits	Teaching Hours/ Week			Marks			
					T	P	Total	Internal		External	
								T	P	T	P
Semester III, Level – 5.0											
DSC-5	DSC	MTH-DSC-231	Calculus of Single Variable	2	2	---	2	20	---	30	---
DSC-6	DSC	MTH-DSC-232	Group Theory	2	2	---	2	20	---	30	---
DSC-7	DSC	MTH-DSC-233	Practical on MTH-DSC-231 and 232	2	---	4	4	---	20	---	30
SEC-1	SEC	MTH-SEC-231	Set Theory and Logic	2	2	---	2	20	---	30	---
CEP	CEP	MTH-CEP-231	Community Engagement Program	2	---	4	4	50	---	---	---
MIN-1	MIN	MTH-MIN-231	Calculus-II	2	2	---	2	20	---	30	---
MIN-2	MIN	MTH-MIN-232	Group Codes	2	2	---	2	20	---	30	---
MIN-3	MIN	MTH-MIN-233	Practical on MTH-MIN-231 and 232	2	---	4	4	---	20	---	30
OE-4	OE	MTH-OE-231	Mathematics for Competitive Exams-III	2	2	---	2	20	---	30	---
Semester IV, Level – 5.0											
DSC-8	DSC	MTH-DSC-241	Calculus of Two and Three Variables	2	2	---	2	20	---	30	---
DSC-9	DSC	MTH-DSC-242	Theory of Ordinary Differential Equations	2	2	---	2	20	---	30	---
DSC-10	DSC	MTH-DSC-243	Practical on MTH-DSC-241 and 242	2	---	4	4	---	20	---	30
SEC-2	SEC	MTH-SEC-241	Introduction to Python	2	2	---	2	20	---	30	---
SEC-3	SEC	MTH-SEC-242	Practical on Python	2	---	4	4	---	20	---	30
FP	FP	MTH-FP-241	Field Project	2	---	4	4	50	---	---	---
MIN-4	MIN	MTH-MIN-241	Theory of Differential Equations	2	2	---	2	20	---	30	---
MIN-5	MIN	MTH-MIN-242	Practical on MTH-MIN-241	2	---	4	4	---	20	---	30
OE-5	OE	MTH-OE-241	Mathematics for Competitive Exams-IV	2	2	---	2	20	---	30	---

Examination Pattern

Theory Question Paper Pattern:

- 30 (External) +20 (Internal) for 2 credits
  - External examination will be of 1½ hours duration
  - There shall be 3 questions: Q1 carrying 6 marks and Q2, Q3 carrying 12 marks each. The tentative pattern of question papers shall be as follows;
  - Q1 : Attempt any 2 out of 3 sub-questions; each 3 marks
  - Q 2 and Q3 : Attempt any 3 out of 4 sub-questions; each 4 marks.

Rules of Continuous Internal Evaluation:

The Continuous Internal Evaluation for theory papers shall consist of two methods:

1. Continuous & Comprehensive Evaluation (CCE): CCE will carry a maximum of 30% weightage (30/15 marks) of the total marks for a course. Before the start of the academic session in each semester, the subject teacher should choose any three assessment methods from the following list, with each method carrying 10/5 marks:

i. Individual Assignments
ii. Seminars/Classroom Presentations/Quizzes
iii. Group Discussions/Class Discussion/Group Assignments
iv. Case studies/Case lets
v. Participatory & Industry-Integrated Learning/Field visits
vi. Practical activities/Problem Solving Exercises
vii. Participation in Seminars/Academic Events/Symposia, etc.
viii. Mini Projects/Capstone Projects
ix. Book review/Article review/Article preparation
x. Any other academic activity
xi. Each chosen CCE method shall be based on a particular unit of the syllabus, ensuring that three units of the syllabus are mapped to the CCEs.

2. Internal Assessment Tests (IAT): IAT will carry a maximum of 10% weightage (10/5 marks) of the total marks for a course. IAT shall be conducted at the end of the semester and will assess the remaining unit of the syllabus that was not covered by the CCEs. The subject teacher is at liberty to decide which units are to be assessed using CCEs and which unit is to be assessed on the basis of IAT. The overall weightage of Continuous Internal Evaluation (CCE + IAT) shall be 40% of the total marks for the course. The remaining 60% of the marks shall be allocated to the semester-end examinations. The subject teachers are required to communicate the chosen CCE methods and the corresponding syllabus units to the students at the beginning of the semester to ensure clarity and proper preparation.

Practical Examination Credit 2: Pattern (30+20)

External Practical Examination (30 marks):

- Practical examination shall be conducted by the respective department at the end of the semester.
- Practical examination will be of 3 hours duration and shall be conducted as per schedule.
- Practical examination shall be conducted for 2 consecutive days for 2 hr/ day where incubation conditionis required.
- There shall be 05 marks for journal and viva-voce. Certified journal is compulsory to appear for practical examination.

Internal Practical Examination (20 marks):

- Internal practical examination of 10 marks will be conducted by department as per schedule given.
- For internal practical examination student must produce the laboratory journal of practicals completed along with the completion certificate signed by the concerned teacher and the Head of the department.
- There shall be continuous assessment of 30 marks based on student performance throughout the semester. This assessment can include quizzes, group discussions, presentations and other activities assigned by the faculty during regular practicals. For details refer internal theory examination guidelines.
- Finally 40 (10+30) marks performance of student will be converted into 20 marks.

SEMESTER-III

S.Y. B.Sc. Mathematics (Major)
Semester-III
MTH-DSC-231: Calculus of Single Variable

Total Hours: 30 **Credits: 2**

Course Objectives	▪ The basic need of this course is to understand the concepts limits and continuity. ▪ To know the Mean Value Theorems and differentiability. ▪ To study the successive differentiation. ▪ To learn the application of differential calculus.	
Course Outcomes	After successful completion of this course, students are expected to: ▪ understand basic concepts on limits and continuity. ▪ know the Mean value theorems and its applications. ▪ understand use of differentiations in various theorems. ▪ make the applications of Taylor's, Maclaurin's theorem.	
Unit	**Contents**	**Hours**

Unit I	**Limit and Continuity**
	▪ Epsilon-delta definition of limit of a function
	▪ Basic properties of limit, Indeterminate form
	▪ L-Hospital's rule
	▪ Examples of limit
	▪ Continuous function
	▪ Properties of continuous function on closed and bounded interval.
	  ▪ Boundedness
	  ▪ Attains its bounds
	  ▪ Indeterminate mean value theorem
		7

Unit II	**Mean Value Theorems** ▪ Differentiability ▪ Definition of derivative ▪ Theorem on continuity and examples ▪ Roll's theorem ▪ Langrage's Mean value theorem ▪ Cauchy's mean value theorem ▪ Examples on Roll's theorem ▪ Langrage's Mean value theorem & Cauchy's mean value theorem ▪ Geometrical interpretation and application ▪ Increasing and Decreasing function	**8**

Unit III	**Successive Differentiation**
	▪ The nth derivative of some standard functions:
	  ▪ e^{ax+b}
	  ▪ x^m
	  ▪ $(ax+b)^m$
	  ▪ $\frac{1}{ax+b}$
	  ▪ $\log(ax+b)$
	  ▪ $\sin(ax+b)$
	  ▪ $\cos(ax+b)$
	  ▪ $e^{ax}\sin(ax+b)$
	  ▪ $e^{ax}\cos(ax+b)$
	▪ Leibnitz's Theorem and examples on it
		7

Unit IV	**Application of differential Calculus** ▪ Taylor's theorem with Lagrange's form of remainder and related examples ▪ Maclaurin' theorem with Lagrange's form of remainder and related examples ▪ Reduction formulae ▪ $\int_0^{\pi/2}(\sin x)^n\,dx$ ▪ $\int_0^{\pi/2}(\cos x)^n\,dx$ ▪ $\int_0^{\frac{\pi}{2}}(\sin x)^m(\cos x)^n\,dx$ ▪ $\int\left(\frac{\sin nx}{\sin x}\right)dx$ and examples on it	**8**
Study Resources	▪ Wrede, R., and Spiegel M. R. (2002). *Theory and Problems of Advanced Calculus* (2nd ed.). McGraw-Hill Company, New York. ▪ Prasad, G. (1959). *Text Book on Differential calculus*. Pothishala Private Ltd., Allahabad. ▪ Prasad, G. *Integral calculus*. Pothishala Private Ltd., Allahabad. ▪ Maron, I. A. *Problems in Calculus of One Variable*. CBS Publishers & Distributors	

S.Y. B.Sc. Mathematics (Major)
Semester-III
MTH-DSC-232: Group Theory

Total Hours: 30 **Credits: 2**

Course Objectives	▪ To know the concept of groups, abelian groups and order of elements and their properties. ▪ To know the concept of subgroups, Lagrange's, Euler's and Fermat's theorem. ▪ To study homomorphism, isomorphism and automorphism of groups. ▪ To study permutations and permutation groups.	
Course Outcomes	After successful completion of this course, students are expected to: ▪ understand group and their types which is one of the building blocks of pure and applied mathematics. ▪ apply Lagrange's, Euler's and Fermat's theorem to solve congruences. ▪ explain concepts of homomorphism, isomorphism and automorphism of groups. ▪ learn basic properties of permutations, even, odd permutation and permutation groups.	
Unit	**Contents**	**Hours**
Unit I	**Groups:** ▪ Groups and its simple properties, Abelian group ▪ Finite and infinite groups ▪ Order of a group, Order of an element and its properties	**7**
Unit II	**Subgroups:** ▪ Subgroups and its simple properties, Criteria for a subgroup ▪ Cyclic groups, Coset decomposition, Lagrange's theorem for finite groups ▪ Euler's theorem and Fermat's theorem.	**8**
Unit III	**Homomorphism and Isomorphism of Groups:** ▪ Group homomorphism and its properties ▪ Kernel of a group homomorphism and it's properties ▪ Isomorphism of groups and its properties	**7**
Unit IV	**Permutation Groups:** ▪ Permutation, Cycle, Transposition, Permutations as a product of disjoint cycles and transpositions ▪ Order of a permutation, Even and odd permutations ▪ Permutation Groups, Alternating Groups	**8**
Study Resources	▪ Gopalakrishnan N. S.(2018). *University Algebra*. Wiley Eastern Limited, New Delhi. (Unit-I: 1.1-1.8, 1.11) ▪ Herstein I. N. (1975). *Topics in Algebra*. John Wiley and Sons, New Delhi. ▪ Fraleigh J. B.(2003). *A first Course in Abstract Algebra*. Pearson. ▪ Khanna Vijay K and Bhambri S. K. (2003). *A course in Abstract Algebra*. Vikas Publishing House Pvt. Ltd., Noida. ▪ Luthar I.S. and Passi I.B.S. (1997). *Algebra, Vol. I: Groups*, Narosa Publishing House.	

S.Y. B.Sc. Mathematics (Major)
Semester-III
MTH-DSC-233: Practical on MTH-DSC-231 and 232

Total Hours: 60 **Credits: 2**

Course Objectives	▪ To know problem solving skills in Calculus of one variables. ▪ To learn the application of differential calculus. ▪ To know problem solving skills in group theory. ▪ To know problem solving skills in permutation group.	
Course Outcomes	After successful completion of this course, students are expected to: ▪ Understand basic concepts on limits and continuity. ▪ Make the applications of Mean value theorem, Taylor's, Maclaurin's theorem. ▪ Apply theorems of Lagrange, Euler and Fermat to solve problems. ▪ Explain concepts and solve problems on homomorphism, isomorphism, automorphism and permutation of groups.	
Sr. No.	**Contents**	**Hours**
1	Limit of function	**4**
2	Continuity of function	**4**
3	Mean Value Theorems-I	**4**
4	Mean Value Theorems-II	**4**
5	Successive Differentiation-I	**4**
6	Successive Differentiation-II	**4**
7	Application of Differential Calculus	**4**
8	Rduction Formulae	**4**
9	Infinite Groups	**4**
10	Finite Groups and Order of Elements	**4**
11	Subgroups	**4**
12	Cyclic Groups, Euler's and Fermat's Theorem	**4**
13	Homomorphism of Groups	**4**
14	Isomorphism of Groups	**4**
15	Permutation Groups	**4**

List of Practicals

Practical No. - 1: Limit of function

1) Evaluate $\lim_{x\to 5} \frac{x^2-4x-5}{x^2+2x-35}$.
2) Evaluate $\lim_{x\to 0} \frac{\tan x - x}{x-\sin x}$.
3) Evaluate $\lim_{x\to 0} \frac{e^{-x}-e^{x}+2x}{x-\sin x}$.
4) Evaluate $\lim_{x\to 0} \frac{xe^{x}-\log(1+x)}{x^2}$.
5) Evaluate $\lim_{x\to 1} \frac{\log x}{x-1}$.

Practical No. - 2: Continuity of function

1) Examine the continuity of the following function at $= 3$, where $f(x) = \begin{cases} \frac{x^2-9}{x-3} & \text{if } 0 \le x < 3 \\ 6 & \text{if } x = 3 \\ 8 - \frac{18}{x^2} & \text{if } x > 3 \end{cases}$.

2) Examine the continuity of the following function at $= 4$, where $f(x) = \begin{cases} \frac{x^2}{4} - 4 & \text{if } 0 \le x < 4 \\ 2 & \text{if } x = 4 \\ 4 - \frac{64}{x^2} & \text{if } x > 4 \end{cases}$.

3) Examine the continuity of the following function at $= a$, where $f(x) = \begin{cases} \frac{x^2}{a} - a & \text{if } 0 \le x < a \\ 0 & \text{if } x = a \\ a - \frac{a^3}{x^2} & \text{if } x > a \end{cases}$.

4) Examine the continuity of the following function at $x = 2$, where $f(x) = \begin{cases} \frac{x^2-4}{x-2} & \text{if } x \neq 2 \\ 4 & \text{if } x = 2 \end{cases}$.

5) Examine the continuity of the following function at $= \frac{1}{2}$, where $f(x) = \begin{cases} \frac{1}{2} - x & \text{if } 0 \le x < \frac{1}{2} \\ 1 & \text{if } x = \frac{1}{2} \\ \frac{3}{2} - x & \text{if } \frac{1}{2} < x \le 1 \end{cases}$.

Practical No. - 3: Mean Value Theorems-I

1) Verify Rolle's theorem for $f(x) = x^2 - 6x + 5$ in $[1,5]$.
2) Verify Rolle's theorem for $f(x) = sinx$ in $[0, \pi]$.
3) Verify Rolle's theorem for $f(x) = (x-a)^m(x-b)^n$ in $[a, b]$.
4) Verify Rolle's theorem for $f(x) = \frac{sinx}{e^x}$ in $[0, \pi]$.
5) Verify Rolle's theorem for $f(x) = x^2 - 1$ in $[-1, 1]$.

Practical No. - 4: Mean Value Theorems-II

1) Verify Lagrange's Mean Value Theorem for $f(x) = 2x^2 - 7x + 10$ in $[2,5]$.
2) Verify Lagrange's Mean Value Theorem for $f(x) = x(x-1)(x-2)$ in $\left[0, \frac{1}{2}\right]$.
3) For $0 < a < b$, show that $1 - \frac{a}{b} < \log\frac{b}{a} < \frac{b}{a} - 1$.
4) Verify Cauchy's Mean Value Theorem for $f(x) = \sin x$ and $g(x) = \cos x$ in $\left[0, \frac{\pi}{2}\right]$.
5) If $f(x) = e^x$ and $g(x) = e^{-x}$ in $[a, b]$, then show that c is the arithmetic mean between a and b by using Cauchy's Mean Value Theorem.

Practical No. - 5: Successive Differentiation-I

1) Find n^{th} derivative of x^m.
2) Find n^{th} derivative of $(ax + b)^m$.
3) If $y = e^{ax+b}$, then find y_n.

4) If $= \frac{1}{ax+b}$, then find y_n.

5) If $y = \log(ax + b)$, then find y_n.

Practical No. - 6: Successive Differentiation-II

1) Find n^{th} derivative of $\frac{1}{1-5x+6x^2}$.

2) If $= \frac{x^2+1}{(x-1)(x-2)(x-3)}$, then find y_n.

3) Find n^{th} derivative of $y = \log\sqrt{\frac{5x+3}{3x-2}}$.

4) If $y = \tan^{-1} x$, then prove that $(1 + x^2)y_{n+1} + 2nxy_n + n(n-1)y_{n-1} = 0$

5) If $y = a\cos(\log x) + b\sin(\log x)$, then show that

i) $x^2y_2 + xy_1 + y = 0$, ii) $x^2y_{n+2} + (2n + 1)xy_{n+1} + (n^2 + 1)y_n = 0$.

Practical No. - 7: Application of differential Calculus

1) Expand $x^4 - 3x^3 + 2x^2 - x + 1$ in powers of $x - 3$.

2) Expand $f(x) = 2x^3 + 7x^2 + x - 1$ in powers of $x - 2$.

3) Expand $f(x) = 2x^3 + 7x^2 + x - 6$ in powers of $x - 2$.

4) Expand the polynomial $x^3 + 2x + 1$ in powers of $x - 2$.

5) Expand x^3 in powers of $x - 1$.

Practical No. - 8: Reduction Formulae

1) Evaluate $\int_0^{\pi/2} \sin^9 x\, dx$

2) Evaluate $\int_0^{\pi/2} \cos^{10} x\, dx$

3) Evaluate $\int_0^{\pi/6} \sin^6 3x\, dx$

4) Evaluate $\int_0^{\pi/2} \sin^3 x \cos^6 x\, dx$

5) Evaluate $\int_0^{\pi/2} \sin^4 x \cos^6 x\, dx$

Practical No. -9: Infinite Groups

1) Verify $\mathbb{N}$ for a group under usual addition operation.

2) Show that $\mathbb{Z}$ is an abelian group under the operation $a * b = a + b + 1$ for all $a, b \in \mathbb{Z}$.

3) Let $\mathbb{Q}^+$ denotes the set of all positive rational numbers and for any $a, b \in \mathbb{Q}^+$, define $a * b = \frac{ab}{2}$. Show that $(\mathbb{Q}^+, *)$ is an abelian group.

4) Let $G = \{(a, b): a, b \in \mathbb{R},\ a \neq 0\}$ and $(a, b)\odot(c, d) = (ac, bc + d)$ for all (a, b), $(c, d) \in G$. Show that the group $(G, \odot)$ is non-abelian.

5) Let $G = \left\{\begin{bmatrix} a & b \\ c & d \end{bmatrix} : \ a, b, c, d \in \mathbb{R}, \ ad - bc \neq 0\right\}$. Prove that G is a non-abelian group under usual matrix multiplication.

Practical No. -10: Finite Groups and Order of Elements

1) Show that $G = \left\{\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}, \begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix}, \begin{bmatrix} -1 & 0 \\ 0 & 1 \end{bmatrix}, \begin{bmatrix} -1 & 0 \\ 0 & -1 \end{bmatrix}\right\}$ is an abelian group under usual matrix multiplication.
2) Show that $\mathbb{Z}_6$ is an abelian group under the addition modulo 6.
3) Find order of every element in the group $G = \{1, -1, \ i, -i\}$ under usual multiplication.
4) Find order of every element in the group $(\mathbb{Z}_6, +_6)$.
5) Find order of every element in the group $(\mathbb{Z}_8', \times_8)$.

Practical No. - 11: Subgroups

1) Let G be a group of all non-zero complex numbers under multiplication. Show that $H = \{a + ib : a^2 + b^2 = 1\}$ is a subgroup of G.
2) Let $G = \mathrm{GL}(2, \mathbb{R})$ be the group of 2×2 non-singular matrices over reals under usual matrix multiplication. Prove that $H = \left\{\begin{bmatrix} a & b \\ c & d \end{bmatrix} \in G : \ ad - bc = 1\right\}$ is a subgroup of G.
3) Let H be a subgroup of a group G and $gHg^{-1} = \{ghg^{-1} : h \in H\}$ is a subgroup of G.
4) Let $G = \{1, -1, \ i, -i, \ j, -j, \ k, -k\}$ be a group under multiplication and $H = \{1, -1, i, -i\}$ be its subgroup. Find all the left and right cosets of H in G.
5) Let $H = \{\bar{0}, \bar{4}, \bar{8}\}$ be a subgroup of the group $(\mathbb{Z}_{12}, +_{12})$. Find all the left and right cosets of H in $\mathbb{Z}_{12}$.

Practical No. - 12: Cyclic Groups, Euler's and Fermat's Theorem

1) Verify the group $(\mathbb{Z}_8', \times_8)$ for a cyclic group.
2) Show that $(\mathbb{Z}_6, +_6)$ is a cyclic group. Find all its generators.
3) Show that every proper subgroup of a group of order 35 is cyclic.
4) Find the remainder when 3^{54} is divided by 11.
5) Find the remainder obtained when 15^{27} is divided by 8.

Practical No. -13: Homomorphism of Groups

1) Let $(\mathbb{R}, +)$ be the group. Show that the function $f : \mathbb{R} \longrightarrow \mathbb{R}$ defined by $f(x) = 2x$ for all $x \in \mathbb{R}$ is a group homomorphism.

2) Let $(\mathbb{R}, +)$ be the group. Examine the function $g: \mathbb{R} \longrightarrow \mathbb{R}$ defined by $g(x) = 2x + 1$ for all $x \in \mathbb{R}$ for a group homomorphism.
3) Let $(\mathbb{Z}, +)$ be the group and $G = \{2^n : n \in \mathbb{Z}\}$, a group under usual multiplication. Show that the function $f: \mathbb{Z} \longrightarrow G$ defined by $f(n) = 2^n$ for all $n \in \mathbb{Z}$, is a group homomorphism. Find its kernel.
4) Let $(\mathbb{Z}, +)$ be the group and $G = \{1, -1, i, -i\}$, a group under usual multiplication. Show that the function $f: \mathbb{Z} \longrightarrow G$ defined by $f(n) = i^n$ for all $n \in \mathbb{Z}$, is an onto group homomorphism.
5) Let $G = \{A : A$ is $n \times n$ matrix over $\mathbb{R}$ and $|A| \neq 0\}$, the group under matrix multiplication and $\mathbb{R}^* = \mathbb{R} - \{0\}$, the group under multiplication. Define $f : G \to \mathbb{R}^*$ by $f(A) = |A|$, for all $A \in G$. Show that f is an onto group homomorphism.

Practical No. - 14: Isomorphism of Groups

1) Show that the function $f : (\mathbb{R}, +) \to (\mathbb{R}^+, \cdot)$ defined by $f(x) = 2^x$ for all $x \in \mathbb{R}$ is an isomorphism.
2) Show that the group $(\mathbb{Q}, +)$ is not isomorphic to the group $(\mathbb{Q}^+, \cdot)$.
3) Let G be a group and $f: G \to G$ be a map defined by $f(x) = x^{-1}$ for all $x \in G$. If f is a group homomorphism, then prove that G is abelian.
4) Let $G = \left\{ \begin{bmatrix} a & b \\ -b & a \end{bmatrix} : a, b \in \mathbb{R},\ a^2 + b^2 = 1 \right\}$ be a group under usual matrix multiplication and $\mathbb{C}^*$ be a group of non-zero complex numbers under multiplication. Show that $f : G \to \mathbb{C}^*$ defined by $f\left(\begin{bmatrix} a & b \\ -b & a \end{bmatrix}\right) = a + ib$ is an isomorphism.
5) Consider the groups $G = \{1, -1, i, -i\}$ under usual multiplication and $\mathbb{Z}_8' = \{\bar{1}, \bar{3}, \bar{5}, \bar{7}\}$ under multiplication modulo 8. Show that G and $\mathbb{Z}_8'$ are not isomorphic.

Practical No. - 15: Permutation Groups

1) If $\sigma = \begin{pmatrix} 1 & 2 & 3 & 4 & 5 & 6 \\ 5 & 4 & 1 & 6 & 3 & 2 \end{pmatrix}$ and $\mu = \begin{pmatrix} 1 & 2 & 3 & 4 & 5 & 6 \\ 2 & 3 & 4 & 1 & 6 & 5 \end{pmatrix}$ in S_6, then find
   i) σ^2 ii) $\mu\sigma$ iii) $\sigma\mu$.
2) If $\mu = \begin{pmatrix} 1 & 2 & 3 & 4 & 5 & 6 & 7 & 8 & 9 \\ 4 & 6 & 2 & 5 & 8 & 9 & 3 & 1 & 7 \end{pmatrix}$ in S_9, then find the order of a permutation μ^{-1}.
3) If $\sigma = \begin{pmatrix} 1 & 2 & 3 & 4 & 5 & 6 \\ 5 & 4 & 1 & 6 & 3 & 2 \end{pmatrix}$ in S_6, then examine σ is even or odd permutation.
4) Prepare a Cayley's table of the permutations on set $A = \{1, 2, 3\}$ for the composition of mappings.
5) List all even permutations in the permutation group S_4.

S.Y. B.Sc. Mathematics (Major)
Semester-III
MTH-SEC-231: Set Theory and Logic

Total Hours: 30 **Credits: 2**

Course Objectives	▪ To acquire concepts of sets, operations on sets, Venn diagrams, countable and uncountable sets. ▪ To acquire concepts of relations, equivalence relations, functions and their types. ▪ To acquire concepts of statements, truth values and logical equivalences. ▪ To acquire concepts of universal and existential quantifiers.	
Course Outcomes	After successful completion of this course, students are expected to: ▪ uses of the language of set theory, designing issues in different subjects of mathematics. ▪ learn how to identify, represent and recognize relations and functions from schematic descriptions, arrow diagrams and graphs. ▪ use truth tables and logical operators to solve the mathematical problems. ▪ provide the logical mathematical reasoning to formulate theorems and definitions.	
Unit	**Contents**	**Hours**
Unit I	**Sets and Subsets:** ▪ Finite Set and Infinite set ▪ Equality of two Sets, ▪ Null Set, Subset, Proper subset and Symmetric difference of two sets ▪ Universal set, Power set and Disjoint sets ▪ Operation on sets: Union and Intersection ▪ Venn diagram ▪ Equivalent sets ▪ Countable and uncountable sets	**7**
Unit II	**Relations and Functions:** ▪ Product of sets ▪ Relations, Types of relations, Reflexive, Symmetric, Transitive relations and Equivalence relations ▪ Function, Types of functions, One-one, Onto, Even, Odd and Inverse function ▪ Composite functions	**8**
Unit III	**Algebra of Propositions:** ▪ Statements, Conjunction, Disjunction. ▪ Negation, Conditional and Bi-Conditional statements, Propositions. ▪ Truth table, Tautology and Contradiction. ▪ Logical equivalence and Logical equivalent statements	**7**
Unit IV	**Quantifiers:** ▪ Propositional functions and Truth sets ▪ Universal quantifier, Existential quantifier ▪ Negation of proposition which contain quantifiers and Counter examples	**8**
Study Resources	▪ *Set Theory and Related Topics*. Schaum's Series, McGraw-Hill, New York. ▪ Halmons, P. R. (1974). *Naïve Set Theory* (Revised ed.). Springer. ▪ Kamke, E. (1950). *Theory of Sets*, Dover Publishers.	

S.Y. B.Sc. Mathematics (Major)
Semester-III
MTH-CEP-231: Community Engagement Program

Course Structure : 2 Credits
Contact hours : 30 hours

In alignment with the National Education Policy (NEP) 2020, Moolji Jaitha College (Autonomous), Jalgaon is introducing the Community Engagement Program at the undergraduate level. The NEP 2020 emphasizes holistic development, inclusivity, and integrating vocational education with academic learning, aiming to nurture socially responsible individuals. Inspired by NEP 2020, the Community Engagement Program aim to produce knowledgeable, compassionate, and proactive graduates, contributing to a more just, equitable, and sustainable society. This course fosters a strong connection between education and socioeconomic problems of real-world. Students will learn about the challenges faced by vulnerable households and appreciate local wisdom and lifestyles.

Objectives

- To engage students in activities that promote emotional, social, and intellectual growth, fostering a well-rounded approach to personal and academic development.
- To provide hands-on experiences that complement classroom learning, enabling students to apply their knowledge in socioeconomic problems of real-world.
- To instil a sense of responsibility towards the community by encouraging students to actively participate in social and environmental initiatives, appreciate rural culture, lifestyle, and wisdom.

Outcomes

After completing this course, students will be able to

- Understand rural and/or urban culture, ethos, and socioeconomic realities.
- Develop a sense of empathy with the local community while appreciating the significant contributions of local communities to society and the economy.
- Learn to value the local community wisdom and identify opportunities for contributing to the community's socioeconomic improvements.

Activities

- Conduct workshops and interactive sessions on emotional intelligence and social skills.
- Organize debates, discussions, and intellectual challenges that stimulate critical thinking and socioeconomic problem-solving using concern subject.
- Organize field visits where students can work on real-world problems, such as environmental conservation, rural and/or urban planning, or community health.
- Organize internships or service-learning opportunities with local businesses, NGOs, or government agencies.
- Facilitate project-based learning activities that require students to use their academic knowledge to develop solutions to community issues.
- Engage students in community service activities that address local social and environmental issues.
- Organize cultural exchange programs or field trips to rural areas to foster an appreciation of rural culture and wisdom.
- Facilitate collaborative projects involving students, educators, and community members to develop solutions for local challenges, promoting teamwork and collective problem-solving.
- Conduct educational sessions on the status of various agricultural and development programs and the challenges faced by vulnerable households, ensuring inclusivity and accessibility for all students.

S. No.	Module Title	Module Content	Assignment submission	Teaching/ Learning Methodology
1	**Appreciation of Rural Society**	Rural lifestyle, rural society, caste and gender relations, rural values with respect to community, nature and resources, elaboration of "soul of India lies in villages', rural infrastructure.	Prepare a map (physical, visual or digital) of the village you visited and write an essay about inter-family relations in that village.	– Classroom discussions – Field visit – Assignment
2	**Understanding rural and local economy and livelihood**	Agriculture, farming, land ownership, water management, animal husbandry, non-farm livelihoods and artisans, rural entrepreneurs, rural markets, migrant labour.	Describe your analysis of the rural house hold economy, its challenges and possible pathways to address. Circular economy and migration patterns.	– Field visit – Group discussions in class – Assignment
3	**Rural and local Institutions**	Traditional rural and community organisations, Self-help Groups, Panchayati raj institutions (Gram Sabha, Gram Panchayat, Standing Committees), Nagarpalikas and municipalities, local civil society, local administration.	How effectively are Panchayati Raj and Urban Local Bodies (ULBs) institutions functioning in the village? What would you suggest to improve their effectiveness? Present a case study (written or audio-visual).	– Classroom – Field visit – Group presentation of assignment
4	**Rural and National Development Programmes**	History of rural development and current national programmes in India: Sarva Shiksha Abhiyan, Beti Bachao, Beti Padhao, Ayushman Bharat, Swachh Bharat, PM Awaas Yojana, Skill India, Gram Panchayat Decentralised Planning, National Rural Livelihood Mission (NRLM), Mahatma Gandhi National Rural Employment Guarantee Act 2005 (MGNREGA), SHRAM, Jal Jeevan Mission, Scheme of Fund for Regeneration of Traditional Industries (SFURTI), Atma Nirbhar Bharat, etc.	Describe the benefits received and challenges faced in the delivery of one of these programmes in the local community; give suggestions about improving the implementation of the programme for the poor. Special focus on the urban informal sector and migrant households.	– Classroom – Each student selects one program for field visit – Written assignment

Note: The modules are suggestive in nature and students can opt any one activities for community engagement program and field project based on topic appropriate to their regional community context.

Some additional suggestive themes for field-based / community engagement activities are listed below:

- Management curriculum may include aspects of micro-financing in a rural context;
- Chemistry syllabus can have a component of conducting water and soil analysis in surrounding field areas;
- Political science syllabus could include a mapping of local rural governance institutions and their functioning.
- Environment education will include areas such as climate change, pollution, waste management, sanitation, conservation of biological diversity, management of biological resources and biodiversity, forest and wildlife conservation, and sustainable development and living
- Understanding panchayats and constitutional mandate of local governance
- Panchayat administration, Gram Sabha, Mahila Sabha, Gram Panchayat Development Plan (GPDP), local planning of basic services.
- Micro-finance, SHGs, system of savings and credit for local business, linkages to banks, financial inclusion.
- Rural – entrepreneurship, opportunities for small business in local communities, access to financial and technical inputs to new entrepreneurs.
- Renewable energy, access to household and community level solar and bio-mass systems for sustainable energy use.
- Participatory Monitoring and evaluation of socio-economic development programmes, and cost-benefit analysis of project proposals.
- Migrant workers' livelihood security and social services.
- Hygiene and sanitation, improving health and personal behaviours, locally manageable decentralised systems and awareness against stubble burning.
- Water conservation, traditional practices of storage and harvesting, new systems of distribution and maintenance.
- Women's empowerment, gender inequality at home, community and public spaces, safety of girls and women, access to skills, credit and work opportunities.
- Child security, safety and good parenting, nutrition and health, learning and training for child care.
- Rural Marketing, market research, designing opportunities for rural artisans and crafts, and new products based on demand assessment.
- Community Based Research in Rural Settings, undertaking research that values local knowledge, systematises local practices and tools for replication and scale-up.
- Peri-urban development of informal settlements, mapping and enumeration, design of local solutions.

Assessment:

- Readings from related literature including e-content and reflections from field visits should be maintained by each student in the form of Field Diary (20 Marks)
- Submission of assignments based on modules assignment submission (details mentioned above) (20 Marks)
- Oral/ Group discussion/ Presentation (10 Marks)

S.Y. B.Sc. Mathematics (Minor)
Semester-III
MTH-MIN-231: Calculus-II

Total Hours: 30 **Credits: 2**

Course Objectives	▪ The basic need of this course is to understand the concepts limits and continuity. ▪ To know the Mean Value Theorems and differentiability. ▪ To study the successive differentiation. ▪ To learn the application of differential calculus.	
Course Outcomes	After successful completion of this course, students are expected to: ▪ understand basic concepts on limits and continuity. ▪ know the Mean value theorems and its applications. ▪ understand use of differentiations in various theorems. ▪ make the applications of Taylor's, Maclaurin's theorem.	
Unit	**Contents**	**Hours**

Unit I	**Limit and Continuity**
	▪ Epsilon-delta definition of limit of a function
	▪ Basic properties of limit, Indeterminate form
	▪ L-Hospital's rule
	▪ Examples of limit
	▪ Continuous function
	▪ Properties of continuous function on closed and bounded interval.
	  ▪ Boundedness
	  ▪ Attains its bounds
	  ▪ Indeterminate mean value theorem
		7

Unit II	**Mean Value Theorems** ▪ Differentiability ▪ Definition of derivative ▪ Theorem on continuity and examples ▪ Roll's theorem ▪ Langrage's Mean value theorem ▪ Cauchy's mean value theorem ▪ Examples on Roll's theorem ▪ Langrage's Mean value theorem & Cauchy's mean value theorem ▪ Geometrical interpretation and application ▪ Increasing and Decreasing function	**8**

Unit III	**Successive Differentiation**
	▪ The nth derivative of some standard functions:
	  ▪ e^{ax+b}
	  ▪ x^m
	  ▪ $(ax+b)^m$
	  ▪ $\frac{1}{ax+b}$
	  ▪ $\log(ax+b)$
	  ▪ $\sin(ax+b)$
	  ▪ $\cos(ax+b)$
	  ▪ $e^{ax}\sin(ax+b)$
	  ▪ $e^{ax}\cos(ax+b)$
	▪ Leibnitz's Theorem and examples on it
		7

Unit IV	**Application of differential Calculus** ▪ Taylor's theorem with Lagrange's form of remainder and related examples ▪ Maclaurin' theorem with Lagrange's form of remainder and related examples	**8**
Study Resources	▪ Wrede, R., and Spiegel M. R. (2002). *Theory and Problems of Advanced Calculus* (2nded.). McGraw-Hill Company, New York. ▪ Prasad, G. (1959). *Text Book on Differential calculus*. Pothishala Private Ltd., Allahabad. ▪ Prasad, G. *Integral calculus*. Pothishala Private Ltd., Allahabad. ▪ Maron, I. A. *Problems in Calculus of One Variable*. CBS Publishers & Distributors	

S.Y. B.Sc. Mathematics (Minor)
Semester-III
MTH-MIN-232: Group Codes

Total Hours: 30 **Credits: 2**

Course Objectives	▪ To know the concept of groups, abelian groups and order of elements and their properties. ▪ To know the concept of subgroups, Lagrange's, Euler's and Fermat's theorem. ▪ To study homomorphism, isomorphism and automorphism of groups. ▪ To know the concept of group codes.	
Course Outcomes	After successful completion of this course, students are expected to: ▪ understand group and their types which is one of the building blocks of pure and applied mathematics. ▪ apply Lagrange's, Euler's and Fermat's theorem to solve congruences. ▪ explain concepts of homomorphism and isomorphism of groups. ▪ learn basic concepts in coding theory.	
Unit	**Contents**	**Hours**
Unit I	**Groups:** ▪ Groups and its simple properties, Abelian group ▪ Finite and infinite groups ▪ Order of a group, Order of an element and its properties	**7**
Unit II	**Subgroups:** ▪ Subgroups and its simple properties, Criteria for a subgroup ▪ Cyclic groups, Coset decomposition, Lagrange's theorem for finite groups ▪ Euler's theorem and Fermat's theorem.	**8**
Unit III	**Homomorphism and Isomorphism of Groups:** ▪ Group homomorphism and its properties ▪ Kernel of a group homomorphism and it's properties ▪ Isomorphism of groups and its properties	**7**
Unit IV	**Group Codes:** ▪ Message, word, (m,n)-encoding function, Code words, Detection of k or fewer errors, Weight, Parity check code ▪ Hamming distance, Properties of the distance function, Minimum distance of an encoding function ▪ Group codes, (n,m)-decoding function, Maximum likelihood decoding function, Decoding procedure for a group code given by a parity check matrix.	**8**
Study Resources	▪ Gopalakrishnan N. S.(2018). *University Algebra*. Wiley Eastern Limited, New Delhi. (Unit-I: 1.1-1.8, 1.11) ▪ Kolman Bernard, Busby Robert C. and Ross. *Discrete Mathematical Structures*. Prentice Hall of India (Eastern Economy Edition), New Delhi. (Unit-XI: 11.1-11.2) ▪ Fraleigh J. B.(2003). *A first Course in Abstract Algebra*. Pearson. ▪ Herstein I. N. (1975). *Topics in Algebra*. John Wiley and Sons, New Delhi. ▪ Jones G. A. and Jones J. M., (2000). *Information and Coding Theory*. Springer. ▪ Khanna Vijay K and Bhambri S. K. (2003). *A course in Abstract Algebra*. Vikas Publishing House Pvt. Ltd., Noida.	

S.Y. B.Sc. Mathematics (Minor)
Semester-III
MTH-MIN-233: Practical on MTH-MIN-231 and 232

Total Hours: 60 **Credits: 2**

Course Objectives	▪ To know problem solving skills in Calculus of one variables. ▪ To learn the application of differential calculus. ▪ To know problem solving skills in group theory. ▪ To know problem solving skills in coding theory.
Course Outcomes	After successful completion of this course, students are expected to: ▪ understand basic concepts on limits and continuity. ▪ make the applications of Mean value theorem, Taylor's, Maclaurin's theorem. ▪ apply theorems of Lagrange, Euler and Fermat to solve problems. ▪ explain concepts and solve problems on homomorphism, isomorphism and automorphism of groups as well as the concepts of coding theory.

Sr. No.	Contents	Hours
1	Limit of function	4
2	Continuity of function	4
3	Mean Value Theorems-I	4
4	Mean Value Theorems-II	4
5	Successive Differentiation-I	4
6	Successive Differentiation-II	4
7	Application of Differential Calculus-I	4
8	Application of Differential Calculus-II	4
9	Infinite Groups	4
10	Finite Groups and Order of Elements	4
11	Subgroups	4
12	Cyclic Groups, Euler's and Fermat's Theorem	4
13	Homomorphism of Groups	4
14	Isomorphism of Groups	4
15	Permutation Groups	4

List of Practicals

Practical No. - 1: Limit of function

1) Evaluate $\lim_{x\to 5} \frac{x^2-4x-5}{x^2+2x-35}$.
2) Evaluate $\lim_{x\to 0} \frac{\tan x - x}{x-\sin x}$.
3) Evaluate $\lim_{x\to 0} \frac{e^{-x}-e^{x}+2x}{x-\sin x}$.
4) Evaluate $\lim_{x\to 0} \frac{xe^{x}-\log(1+x)}{x^2}$.
5) Evaluate $\lim_{x\to 1} \frac{\log x}{x-1}$.

Practical No. - 2: Continuity of function

1) Examine the continuity of the following function at $= 3$, where $f(x) = \begin{cases} \frac{x^2-9}{x-3} & \text{if } 0 \le x < 3 \\ 6 & \text{if } x = 3 \\ 8 - \frac{18}{x^2} & \text{if } x > 3 \end{cases}$.

2) Examine the continuity of the following function at $= 4$, where $f(x) = \begin{cases} \frac{x^2}{4} - 4 & \text{if } 0 \le x < 4 \\ 2 & \text{if } x = 4 \\ 4 - \frac{64}{x^2} & \text{if } x > 4 \end{cases}$.

3) Examine the continuity of the following function at $= a$, where $f(x) = \begin{cases} \frac{x^2}{a} - a & \text{if } 0 \le x < a \\ 0 & \text{if } x = a \\ a - \frac{a^3}{x^2} & \text{if } x > a \end{cases}$.

4) Examine the continuity of the following function at $x = 2$, where $f(x) = \begin{cases} \frac{x^2-4}{x-2} & \text{if } x \neq 2 \\ 4 & \text{if } x = 2 \end{cases}$.

5) Examine the continuity of the following function at $= \frac{1}{2}$, where $f(x) = \begin{cases} \frac{1}{2} - x & \text{if } 0 \le x < \frac{1}{2} \\ 1 & \text{if } x = \frac{1}{2} \\ \frac{3}{2} - x & \text{if } \frac{1}{2} < x \le 1 \end{cases}$.

Practical No. - 3: Mean Value Theorems-I

1) Verify Rolle's theorem for $f(x) = x^2 - 6x + 5$ in $[1,5]$.
2) Verify Rolle's theorem for $f(x) = sinx$ in $[0, \pi]$.
3) Verify Rolle's theorem for $f(x) = (x-a)^m(x-b)^n$ in $[a, b]$.
4) Verify Rolle's theorem for $f(x) = \frac{sinx}{e^x}$ in $[0, \pi]$.
5) Verify Rolle's theorem for $f(x) = x^2 - 1$ in $[-1, 1]$.

Practical No. - 4: Mean Value Theorems-II

1) Verify Lagrange's Mean Value Theorem for $f(x) = 2x^2 - 7x + 10$ in $[2,5]$.
2) Verify Lagrange's Mean Value Theorem for $f(x) = x(x-1)(x-2)$ in $\left[0, \frac{1}{2}\right]$.
3) For $0 < a < b$, show that $1 - \frac{a}{b} < \log\frac{b}{a} < \frac{b}{a} - 1$.
4) Verify Cauchy's Mean Value Theorem for $f(x) = \sin x$ and $g(x) = \cos x$ in $\left[0, \frac{\pi}{2}\right]$.
5) If $f(x) = e^x$ and $g(x) = e^{-x}$ in $[a, b]$, then show that c is the arithmetic mean between a and b by using Cauchy's Mean Value Theorem.

Practical No. - 5: Successive Differentiation-I

1) Find n^{th} derivative of x^m.
2) Find n^{th} derivative of $(ax + b)^m$.
3) If $y = e^{ax+b}$, then find y_n.

4) If $= \frac{1}{ax+b}$, then find y_n.

5) If $y = \log(ax + b)$, then find y_n.

Practical No. - 6: Successive Differentiation-II

1) Find n^{th} derivative of $\frac{1}{1-5x+6x^2}$.

2) If $= \frac{x^2+1}{(x-1)(x-2)(x-3)}$, then find y_n.

3) Find n^{th} derivative of $y = \log\sqrt{\frac{5x+3}{3x-2}}$.

4) If $y = \tan^{-1} x$, then prove that $(1 + x^2)y_{n+1} + 2nxy_n + n(n-1)y_{n-1} = 0$

5) If $y = a\cos(\log x) + b\sin(\log x)$, then show that

i) $x^2y_2 + xy_1 + y = 0$, ii) $x^2y_{n+2} + (2n + 1)xy_{n+1} + (n^2 + 1)y_n = 0$.

Practical No. - 7: Application of differential Calculus-I

1) Expand $x^4 - 3x^3 + 2x^2 - x + 1$ in powers of $x - 3$.

2) Expand $f(x) = 2x^3 + 7x^2 + x - 1$ in powers of $x - 2$.

3) Expand $f(x) = 2x^3 + 7x^2 + x - 6$ in powers of $x - 2$.

4) Expand the polynomial $x^3 + 2x + 1$ in powers of $x - 2$.

5) Expand x^3 in powers of $x - 1$.

Practical No. - 8: Application of differential Calculus-II

1) Expand $\sin x$ about $x = \frac{\pi}{2}$.

2) Write the expansion of $\sin x$ about origin.

3) Expand e^x about origin.

4) Expand $\cos x$ about origin.

5) Expand $\log(1 + x)$ about origin.

Practical No. -9: Infinite Groups

1) Verify $\mathbb{N}$ for a group under usual addition operation.

2) Show that $\mathbb{Z}$ is an abelian group under the operation $a * b = a + b + 1$ for all $a, b \in \mathbb{Z}$.

3) Let $\mathbb{Q}^+$ denotes the set of all positive rational numbers and for any $a, b \in \mathbb{Q}^+$, define $a * b = \frac{ab}{2}$. Show that $(\mathbb{Q}^+, *)$ is an abelian group.

4) Let $G = \{(a, b): a, b \in \mathbb{R},\ a \neq 0\}$ and $(a, b)\odot(c, d) = (ac, bc + d)$ for all (a, b), $(c, d) \in G$. Show that the group $(G, \odot)$ is non-abelian.

5) Let $G = \left\{\begin{bmatrix} a & b \\ c & d \end{bmatrix} : \ a, b, c, d \in \mathbb{R}, \ ad - bc \neq 0\right\}$. Prove that G is a non-abelian group under usual matrix multiplication.

Practical No. -10: Finite Groups and Order of Elements

1) Show that $G = \left\{\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}, \begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix}, \begin{bmatrix} -1 & 0 \\ 0 & 1 \end{bmatrix}, \begin{bmatrix} -1 & 0 \\ 0 & -1 \end{bmatrix}\right\}$ is an abelian group under usual matrix multiplication.
2) Show that $\mathbb{Z}_6$ is an abelian group under the addition modulo 6.
3) Find order of every element in the group $G = \{1, -1, \ i, -i\}$ under usual multiplication.
4) Find order of every element in the group $(\mathbb{Z}_6, +_6)$.
5) Find order of every element in the group $(\mathbb{Z}_8', \times_8)$.

Practical No. - 11: Subgroups

1) Let G be a group of all non-zero complex numbers under multiplication. Show that $H = \{a + ib : a^2 + b^2 = 1\}$ is a subgroup of G.
2) Let $G = \mathrm{GL}(2, \mathbb{R})$ be the group of 2×2 non-singular matrices over reals under usual matrix multiplication. Prove that $H = \left\{\begin{bmatrix} a & b \\ c & d \end{bmatrix} \in G : \ ad - bc = 1\right\}$ is a subgroup of G.
3) Let H be a subgroup of a group G and $gHg^{-1} = \{ghg^{-1} : h \in H\}$ is a subgroup of G.
4) Let $G = \{1, -1, \ i, -i, \ j, -j, \ k, -k\}$ be a group under multiplication and $H = \{1, -1, i, -i\}$ be its subgroup. Find all the left and right cosets of H in G.
5) Let $H = \{\bar{0}, \bar{4}, \bar{8}\}$ be a subgroup of the group $(\mathbb{Z}_{12}, +_{12})$. Find all the left and right cosets of H in $\mathbb{Z}_{12}$.

Practical No. - 12: Cyclic Groups, Euler's and Fermat's Theorem

1) Verify the group $(\mathbb{Z}_8', \times_8)$ for a cyclic group.
2) Show that $(\mathbb{Z}_6, +_6)$ is a cyclic group. Find all its generators.
3) Show that every proper subgroup of a group of order 35 is cyclic.
4) Find the remainder when 3^{54} is divided by 11.
5) Find the remainder obtained when 15^{27} is divided by 8.

Practical No. -13: Homomorphism of Groups

1) Let $(\mathbb{R}, +)$ be the group. Show that the function $f: \mathbb{R} \longrightarrow \mathbb{R}$ defined by $f(x) = 2x$ for all $x \in \mathbb{R}$ is a group homomorphism.
2) Let $(\mathbb{R}, +)$ be the group. Examine the function $g: \mathbb{R} \longrightarrow \mathbb{R}$ defined by $g(x) = 2x + 1$ for all $x \in \mathbb{R}$ for a group homomorphism.
3) Let $(\mathbb{Z}, +)$ be the group and $G = \{2^n : n \in \mathbb{Z}\}$, a group under usual multiplication. Show that the function $f: \mathbb{Z} \longrightarrow G$ defined by $f(n) = 2^n$ for all $n \in \mathbb{Z}$, is a group homomorphism. Find its kernel.
4) Let $(\mathbb{Z}, +)$ be the group and $G = \{1, -1, i, -i\}$, a group under usual multiplication. Show that the function $f: \mathbb{Z} \longrightarrow G$ defined by $f(n) = i^n$ for all $n \in \mathbb{Z}$, is an onto group homomorphism.
5) Let $G = \{A : A$ is $n \times n$ matrix over $\mathbb{R}$ and $|A| \neq 0\}$, the group under matrix multiplication and $\mathbb{R}^* = \mathbb{R} - \{0\}$, the group under multiplication. Define $f : G \rightarrow \mathbb{R}^*$ by $f(A) = |A|$, for all $A \in G$. Show that f is an onto group homomorphism.

Practical No. -14: Isomorphism of Groups

1) Show that the function $f : (\mathbb{R}, +) \rightarrow (\mathbb{R}^+, \cdot)$ defined by $f(x) = 2^x$ for all $x \in \mathbb{R}$ is an isomorphism.
2) Show that the group $(\mathbb{Q}, +)$ is not isomorphic to the group $(\mathbb{Q}^+, \cdot)$.
3) Let G be a group and $f: G \rightarrow G$ be a map defined by $f(x) = x^{-1}$ for all $x \in G$. If f is a group homomorphism, then prove that G is abelian.
4) Let $G = \left\{\begin{bmatrix} a & b \\ -b & a \end{bmatrix} : a, b \in \mathbb{R},\ a^2 + b^2 = 1\right\}$ be a group under usual matrix multiplication and $\mathbb{C}^*$ be a group of non-zero complex numbers under multiplication. Show that $f : G \rightarrow \mathbb{C}^*$ defined by $f\left(\begin{bmatrix} a & b \\ -b & a \end{bmatrix}\right) = a + ib$ is an isomorphism.
5) Consider the groups $G = \{1, -1, i, -i\}$ under usual multiplication and $\mathbb{Z}_8' = \{\bar{1}, \bar{3}, \bar{5}, \bar{7}\}$ under multiplication modulo 8. Show that G and $\mathbb{Z}_8'$ are not isomorphic.

Practical No.-15: Group Codes

1) Find $(3, 4)$ parity check code.
2) Consider the $(2, 4)$-encoding function $e : B^2 \rightarrow B^4$ defined by $e(00) = 0000, e(10) = 0110, e(01) = 1011, e(11) = 1100$.
   a) Find the minimum distance of e.
   b) How many errors will e detect?

3) Compute: (a) $\begin{bmatrix}1 & 0 & 1\\ 1 & 1 & 0\\ 0 & 1 & 0\\ 0 & 0 & 1\end{bmatrix} \oplus \begin{bmatrix}1 & 1 & 0\\ 0 & 0 & 1\\ 1 & 1 & 0\\ 0 & 1 & 0\end{bmatrix}$ (b) $\begin{bmatrix}1 & 1 & 0\\ 1 & 0 & 1\\ 0 & 1 & 0\end{bmatrix} * \begin{bmatrix}1 & 1 & 1\\ 0 & 0 & 1\\ 1 & 1 & 0\end{bmatrix}$.

4) Consider the $(2, 5)$ encoding function defined by $e(00) = 00000, e(10) = 10101, e(01) = 01110, e(11) = 11011$. Show that $e: B^2 \rightarrow B^5$ is a group code.

5) Let $H = \begin{bmatrix}0 & 1 & 1\\ 0 & 1 & 1\\ 1 & 0 & 0\\ 0 & 1 & 0\\ 0 & 0 & 1\end{bmatrix}$ be a parity check matrix. Determine the (2 , 5) group code $e_H: B^2 \rightarrow B^5$.

S.Y. B.Sc. Mathematics (Open Elective)
Semester-III
MTH-OE-231: Mathematics for Competitive Exams-III

Total Hours: 30 **Credits: 2**

Course Objectives	▪ The main aim of introducing Mathematics for Competitive Examinations-III for students is to develop the skill to meet the competitive examinations for better job opportunities. ▪ Solve the laws of indices and logarithms to real-world problems. ▪ Attract the students to attain the mathematical problems and create interest in students about mathematics. ▪ Calculate the area of composite and irregular shapes by decomposition into simpler parts.	
Course Outcomes	After successful completion of this course, students are expected to: ▪ explain the meaning and properties of surds, indices, and logarithms. ▪ grasp the approaches and strategies to solve problems with speed and accuracy. ▪ develop reasoning and problem-solving skill in determining are-related solutions. ▪ solve problems easily by using a simple method.	
Unit	**Contents**	**Hours**
Unit I	**Simplification** ▪ Modulus of a Real Number ▪ Virnaculum (or Bar) ▪ Square Root ▪ Cube Root	**7**
Unit II	**Logarithms** ▪ Laws of Indices and Surds ▪ Logarithm and its properties	**8**
Unit III	**Chain Rule** ▪ Direct Proportion ▪ Indirect Proportion ▪ Alligation ▪ Mean Price and Rule of Alligation	**8**
Unit IV	**Area** ▪ Results on Triangles ▪ Results on Quadrilaterals	**7**
Study Resources	▪ Aggarwal, R. S. (2018). Quantitative Aptitude for Competitive Examinations (Revised ed.). S. Chand and Co. Ltd, New Delhi. (Section–I : Art.4-5, Art.9-10, Art.15, Art.21, Art.24.) ▪ Praveen, R. V. Quantitative Aptitude and Reasoning. PHI publishers. ▪ Quantitative Aptitude: Numerical Ability (Fully Solved) Objective Questions. Kiran Prakashan, Pratogitaprakasan, Kic X, Kiran Prakasan publishers. ▪ Guha, A. Quantitative Aptitude for Competitive Examination. Tata Mc Graw hill publications.	

SEMESTER-IV

S.Y. B.Sc. Mathematics (Major)
Semester-IV
MTH-DSC-241: Calculus of Two and Three Variables

Total Hours: 30 **Credits: 2**

Course Objectives	▪ To know scope and importance of functions of two and more variables. ▪ To learn composite functions and Mean value theorem. ▪ To study series expansions and extreme values. ▪ To know integration techniques as well as applications of integrals.	
Course Outcomes	After successful completion of this course, students are expected to: ▪ understand limit and continuity of functions of several variables. ▪ solve the problems using Mean value theorem. ▪ explain fundamental concepts of multivariable calculus and series expansion of functions. ▪ learn how to solve double and triple integration and use them to find area by double integration and volume by triple integration.	
Unit	**Content**	**Hours**
Unit I	**Functions of Two and Three Variables:** ▪ Explicit and implicit functions ▪ Continuity, Partial derivatives and Differentiability ▪ Partial derivatives of higher order ▪ Schwarz's theorem and Young's theorem.	**7**
Unit II	**Composite Functions and Mean Value Theorem:** ▪ Composite functions (chain rule) ▪ Homogeneous functions and Euler's theorem ▪ Mean value theorem for functions of two variables.	**8**
Unit III	**Taylor's Theorem and Extreme Values:** ▪ Taylor's and Maclaurin's theorem for functions of two variables ▪ Maxima and minima: Absolute, Relative ▪ Critical and Saddle point ▪ Sufficient condition for extrema	**7**
Unit IV	**Double and Triple Integrals:** ▪ Double integrals by using Cartesian and polar coordinates ▪ Change of order of integration ▪ Area by double integral ▪ Volume by triple integral.	**8**
Study Resources	▪ Malik S.C. and Arora Savita (1992). *Mathematical Analysis*. Wiley Eastern Ltd, New Delhi. (Ch.15 Art. 1, 2, 3, 4, 5, 7, 9, 10, 11, Ch.17 Art.2, 3, 7). ▪ Rogers Robert C. (2011). *Calculus of Several Variables*. Schaum's Outline Series. ▪ Apostol T. M.(1985). *Mathematical Analysis*. Narosa Publishing House, New Delhi.	

S.Y. B.Sc. Mathematics (Major)
Semester-IV
MTH-DSC-242: Theory of Ordinary Differential Equations

Total Hours: 30 **Credits: 2**

Course Objectives	▪ Evaluate first order differential equations including homogeneous, exact and linear differential equations. ▪ Solve the first order and higher degree differential equations. ▪ Solve second order and higher orders linear differential equations. ▪ To know the concept of homogeneous linear differential equations.	
Course Outcomes	After successful completion of this course, students are expected to: ▪ understand basic concepts in differential equations. ▪ solve the differential equations using solvable for x, y, p and Clairaut's form. ▪ solve the linear differential equations of second and higher order. ▪ understand the method of solving the homogeneous linear differential equation.	
Unit	**Contents**	**Hours**
Unit I	**Differential Equations of First Order and First Degree:** ▪ Partial derivatives of first order and second orders ▪ Exact differential equations and Condition for exactness ▪ Integrating factor and its rules ▪ Linear differential equations ▪ Bernoulli's Differential Equation ▪ Equation reducible to linear form	**7**
Unit II	**Differential Equations of First Order and Higher Degree:** ▪ Differential equations of first order and higher degree ▪ Equation solvable for x, y and p ▪ Clairaut's form	**8**
Unit III	**Linear Differential Equations of Second and Higher Order:** ▪ Linear differential equations with constant coefficients ▪ Complementary functions ▪ Particular integrals of $f(D)y = X$, where $X = e^{ax}$, $\sin(ax)$, $\cos(ax)$, $x^n, e^{ax}V, xV$ with usual notations	**7**
Unit IV	**Homogeneous Linear Differential Equations:** ▪ Homogeneous linear differential equations (Cauchy's differential equations) ▪ Example of Homogeneous linear differential equations ▪ Equations reducible to homogeneous linear differential equations (Legendre's equations) ▪ Example of Equations reducible to homogeneous linear differential equations	**8**
Study Resources	▪ Murray, D. A. **(**1967**).** *Introductory Course in Differential Equations***.** Orient Congman (India). ▪ Simmons, G. F. **(**1972**).** *Differential Equations*, Tata McGraw Hill.	

S.Y. B.Sc. Mathematics (Major)
Semester-IV
MTH-DSC-243: Practical on MTH-DSC-241 and 242

Total Hours: 60 **Credits: 2**

Course Objectives	▪ To study series expansions and extreme values. ▪ To know integration techniques as well as applications of integrals. ▪ The basic need of this course is to understand the different methods of solving differential equations and their applications to solve problems. ▪ Evaluate differential equations including homogeneous, exact and linear differential equations.
Course Outcomes	After successful completion of this course, students are expected to: ▪ understand limit and continuity of functions of several variables. ▪ understand the concept of double and triple integration as well as its applications. ▪ understand method of solving differential equations. ▪ understand the method of solving the homogeneous linear differential equation.

Sr. No.	Contents	Hours
1	Functions of Two and Three Variables-I	**4**
2	Functions of Two and Three Variables-II	**4**
3	Composite Functions and Mean Value Theorems-I	**4**
4	Composite Functions and Mean Value Theorems-II	**4**
5	Taylor's Theorem and Extreme Values-I	**4**
6	Taylor's Theorem and Extreme Values-II	**4**
7	Double Integrals	**4**
8	Triple Integrals	**4**
9	Partial derivative and Exact Differential Equations	**4**
10	Integrating Factor and Bernoulli's Equation	**4**
11	Equations Solvable for p and y	**4**
12	Equations Solvable for x and Clairaut's Equation	**4**
13	Complementary Function and Particular Integrable Type I	**4**
14	Particular Integrable Type II, III, IV	**4**
15	Homogeneous linear Equations	**4**

List of Practicals

Practical No.-1: Functions of Two and Three Variables-I

1) Evaluate: $\lim_{(x,y)\to(0,0)} \frac{xy^3}{x^2+y^6}$.

2) If $u = x^2y + y^2z + z^2x$, then show that $\frac{\partial u}{\partial x} + \frac{\partial u}{\partial y} + \frac{\partial u}{\partial z} = (x + y + z)^2$.

3) Evaluate: $\lim_{(x,y)\to(0,0)} \frac{x^2y^4}{(x^2+y^4)^2}$.

4) Examine the continuity of the function $f(x,y) = \begin{cases} \frac{xy}{\sqrt{x^2+y^2}} & ,if\ (x,y) \neq (0,0) \\ 0 & ,if\ (x,y) = (0,0) \end{cases}$.

5) Using differentials, find the approximate value of $(2.01)(3.02)^2$.

Practical No.-2: Functions of Two and Three Variables-II

1) Evaluate $\lim_{(x,y)\to(0,0)} \frac{xy}{x^2+y^2}$.
2) If $u = x^3 z + xy^2 - 2yz$ find $\frac{\partial u}{\partial x}$, $\frac{\partial u}{\partial y}$ and $\frac{\partial u}{\partial z}$.
3) Let $f(x,y) = \frac{x^2y^2}{x^2+y^2}$, $x^2 + y^2 \neq 0$. Show that $f_{xy}(0,0) = f_{yx}(0,0)$.
4) Find the approximate value of the function $(3.9)^2(2.05) + (2.05)^3$.
5) Examine the continuity of the following function at $(0,0)$, where $f(x,y) = \begin{cases} \frac{x^2y}{x^3+y^3} & if\ (x,y) \neq (0,0), \\ 0 & if\ (x,y) = (0,0). \end{cases}$

Practical No.-3: Composite Functions and Mean Value Theorems-I

1) Let $z = f(u,v)$, where $u = 2x - 3y$ and $v = x + 2y$. Prove that $\frac{\partial z}{\partial x} + \frac{\partial z}{\partial y} = 3\frac{\partial z}{\partial v} - \frac{\partial z}{\partial u}$.
2) If $= \tan^{-1}\left[\frac{x^3+y^3}{x-y}\right]$, then find the value of (1) $x\frac{\partial u}{\partial x} + y\frac{\partial u}{\partial y}$, (2) $x^2\frac{\partial^2 u}{\partial x^2} + 2xy\frac{\partial^2 u}{\partial x \partial y} + y^2\frac{\partial^2 u}{\partial y^2}$.
3) Find $\frac{dz}{dt}$ when $z = xy^2 + x^2y$, $x = at^2$, $y = 2at^2$.
4) If $z = x^2 + y^2$ where $x = t^2 + 1$, $y = 2t$, then find $\frac{dz}{dt}$ at $t = 1$.
5) Verify Euler's theorem for the function $f(x,y) = x^3 + y^3 - 3x^2y$.

Practical No.-4: Composite Functions and Mean Value Theorems-II

1) If $z = f(x,y)$, where $x = e^u + e^{-v}$ and $y = e^{-u} + e^v$, then show that $\frac{\partial z}{\partial u} - \frac{\partial z}{\partial v} = x\frac{\partial z}{\partial x} - y\frac{\partial z}{\partial y}$.
2) If $u = sin^{-1}\frac{x^2+y^2}{x+y}$, then find the value of $x\frac{\partial u}{\partial x} + y\frac{\partial u}{\partial y}$.
3) If $u = \log(x^3 + y^3 - x^2y - xy^2)$, then find the value of $x\frac{\partial u}{\partial x} + y\frac{\partial u}{\partial y}$.
4) If $f(x,y) = x^2y + 2xy^2$, then show that θ used in mean value theorem applied to the line segment joining $(1,2)$ to $(3,3)$ satisfied the equation $12\theta^2 + 13\theta - 19 = 0$.
5) Verify the Euler's theorem for $f(x,y) = x^2 + y^2 + xy$.

Practical No.-5: Taylor's Theorem and Extreme Values-I

1) Expand $x^3 + y^3 + xy^2$ in powers of $(x-1)$ and $(y-2)$.
2) Expand $f(x,y) = x^2 + xy - y^2$ by Taylor's theorem in powers of $(x-1)$ and $(y+2)$.
3) Prove that $\sin(x+y) = (x+y) - \frac{(x+y)^3}{3!} + \cdots$
4) Expand $f(x,y) = \sin xy$ in powers of $(x-1)$ and $\left(y - \frac{\pi}{2}\right)$ up to and including terms of second degree.
5) Discuss the maxima and minima of the function $(x,y) = x^2 + y^2 + \frac{2}{x} + \frac{2}{y}$.

Practical No.-6: Taylor's Theorem and Extreme Values-II

1) Expand $e^x \log(1+y)$ in powers of x and y.
2) Expand $e^{2x}\cos y$ as a Taylors series about $(0,0)$.
3) Find the critical point or stationary point for $f(x,y) = x^2 + y^2$.
4) Discuss the extreme values for $f(x,y) = 2(x^2 - y^2) - x^4 + y^4$.
5) Find the least value of the function $f(x,y) = xy + \frac{50}{x} + \frac{50}{y}$.

Practical No.-7: Double Integrals

1) Evaluate $\int_0^a \int_0^b (x^2 + y^2) dxdy$.
2) Evaluate $\int_0^a \int_{\frac{x}{a}}^{x} \frac{x}{x^2+y^2} dxdy$.
3) Evaluate $\iint_R xy(x+y)dxdy$ where R is the region bounded by $y = x^2$ and $y = x$.
4) Evaluate $\iint ydxdy$ over the region bounded by $y = x^2$ and $x + y = 2$.
5) Find the area bounded by the parabola $y^2 = 2x$ and $x^2 = 2y$.

Practical No.-8: Triple Integrals

1) Evaluate $\int_0^1 \int_0^1 \int_0^1 (x+y+z)dxdydz$.
2) Evaluate $\int_0^1 \int_0^{1-x} \int_0^{x+y} e^z dxdydz$.
3) Using triple integration, find the volume of sphere having radius a.
4) Evaluate $\int_0^1 \int_0^2 \int_0^3 (x+y+z)dxdydz$.
5) Find the volume of the region bounded by the plane $x = 0$, $y = 0$, $z = 0$ and $x + y + z = 1$.

Practical No.-9: Partial derivative and Exact Differential Equations

1. If $u = x^3z + xy^2 - 2yz$ then find $\frac{\partial u}{\partial x}$, $\frac{\partial u}{\partial y}$ and $\frac{\partial u}{\partial z}$ at the point (1,2,3).
2. If $= x^2y + y^2z + z^2x$, then show that $\frac{\partial u}{\partial x} + \frac{\partial u}{\partial y} + \frac{\partial u}{\partial z} = (x+y+z)^2$.
3. If $(x+y) = x^2 + y^2$, then prove that $(\frac{\partial u}{\partial x} - \frac{\partial u}{\partial y})^2 = 4(1 - \frac{\partial u}{\partial x} - \frac{\partial u}{\partial y})$.
4. Solve $(e^x + 1)cosxdx + e^y sinxdy = 0$.
5. Solve $(2x - y + 1)dx + (2y - x - 1)dy = 0$.

Practical No.-10: Integrating Factor and Bernoulli's Equation

1. Solve $x^2ydx - (x^3 + y^3)dy = 0$.

2. Solve $(x^2 - 5xy + 7y^2)dx + (5x^2 - 7xy)dy = 0$.
3. Solve $(1 + xy)ydx + (1 - xy)xdy = 0$.
4. Solve $\frac{dy}{dx} - ytanx = -y^2secx$.
5. Solve $\frac{dy}{dx} + ycosx = y^n sin2x$.

Practical No.-11: Equations Solvable for p and y

1. Solve $p^2 - 7p + 10 = 0$.
2. Solve $p - \frac{1}{p} = \frac{x}{y} - \frac{y}{x}$.
3. Solve $xyp^2 + (x^2 + xy + y^2)p + x(x + y) = 0$.
4. Solve $y + px = x^4p^2$.
5. Solve $y = 2px - p^2$.

Practical No.-12: Equations Solvable for x and Clairaut's Equation

1. Solve $y = 3px + 6y^2p^2$.
2. Solve $y = 2px - p^2y$.
3. Solve $y = px + a\sqrt{1 + p^2}$.
4. Solve $xp^2 - yp + a = 0$.
5. Solve $p = tan(px - y)$.

Practical No.-13: Complementary Function and Particular Integrable Type I

1. Solve $\frac{d^2y}{dx^2} + 5\frac{dy}{dx} + 6y = 0$.
2. Solve $\frac{d^2y}{dx^2} + 13\frac{dy}{dx} + 12y = 0$.
3. Solve $(D^3 - 3D + 4)y = 0$.
4. Solve $\frac{d^2y}{dx^2} + 4\frac{dy}{dx} + 4y = e^{2x}$.
5. Solve $\frac{d^2y}{dx^2} - \frac{dy}{dx} - 6y = e^x cosh2x$.

Practical No.-14: Particular Integrable Type II, III, IV

1. Solve $\frac{d^2y}{dx^2} - 9y = e^{2x} + x^2$.
2. Solve $\frac{d^2y}{dx^2} + 8y = x^4 + 2x + 1$.
3. Solve $(D^2 - 2D + 1)y = x^2e^{3x}$.
4. Solve $(D^2 - 4D + 3)y = e^x cos2x$.
5. Solve $(D^2 - 1)y = x^2 sinx$.

Practical No.-15: Homogeneous linear Equations

1. Solve $x^2\frac{d^2y}{dx^2} + x\frac{dy}{dx} - 4y = 0$.

2. Solve $x^2\frac{d^2y}{dx^2} - 3x\frac{dy}{dx} + 4y = 2x^2$.
3. Solve $\frac{d^2y}{dx^2} - \frac{1}{x}\frac{dy}{dx} + \frac{y}{x^2} = \frac{2logz}{x^2}$.
4. Solve $x^2\frac{d^2y}{dx^2} - x\frac{dy}{dx} - 3y = x^2logx$.
5. Solve $x^2\frac{d^2y}{dx^2} - 3x\frac{dy}{dx} + 5y = x^2sinlogx$.

S.Y. B.Sc. Mathematics (Major)
Semester-IV
MTH-SEC-241: Introduction to Python

Total Hours: 30 **Credits: 2**

Course Objectives	▪ To understand basic of Python. ▪ To study strings in Python. ▪ To know operators, lists and tuples. ▪ To know sets, dictionaries and arrays.	
Course Outcomes	After successful completion of this course, students are expected to: ▪ installation of Python and use of it. ▪ know data types, numbers, casting and strings. ▪ use various operatgors in Python. ▪ familier to use sets, dictionaries and arrays in Python.	
Unit	**Contents**	**Hours**
Unit I	**Basic of Python** ▪ Python Introduction ▪ Python Install ▪ Python Syntax ▪ Python Comments ▪ Python Variables	**7**
Unit II	**Strings** ▪ Python Data Types ▪ Python Numbers ▪ Python Casting ▪ Python Strings	**8**
Unit III	**Operators, Lists and Tuples** ▪ Python Booleans ▪ Python Operators ▪ Python Lists ▪ Python Tuples	**7**
Unit IV	**Sets, Dictionaries and Arrays** ▪ Python Sets ▪ Python Dictionaries ▪ Python Arrays ▪ Python Datetime	**8**
Study Resources	▪ Downey, A. (2015). *Think Python: How to Think Like a Computer Scientist* (2nd ed.). O'Reilly Media, Inc. ▪ Johansson, R. (2019). *Numerical Python: Scientific Computing and Data Science Applications with Numpy, SciPy and Matplotlib* (2nd ed.). Apress. ▪ Langtangen, H. P. (2009). *Python Scripting for Computational Science* (3rd ed.). Springer Berlin Heidelberg.	

S.Y. B.Sc. Mathematics (Major)
Semester-IV
MTH-SEC-242: Practical on Python

Total Hours: 60 **Credits: 2**

Course Objectives	▪ To understand basic of Python. ▪ To study strings in Python. ▪ To know operators, lists and tuples. ▪ To know sets, dictionaries and arrays.	
Course Outcomes	After successful completion of this course, students are expected to: ▪ installation of Python and use of it. ▪ know data types, numbers, casting and strings. ▪ use various operatgors in Python. ▪ familier to use sets, dictionaries and arrays in Python.	
Sr. No.	**Contents**	**Hours**
1	Installation of Python and syntax	**4**
2	Python Comments	**4**
3	Python Variables-I	**4**
4	Python Variables-II	**4**
5	Data Types	**4**
6	Python Numbers	**4**
7	Python Strings-I	**4**
8	Python Strings-II	**4**
9	Operators-I	**4**
10	Operators-II	**4**
11	Python Lists	**4**
12	Python Tuples	**4**
13	Sets	**4**
14	Dictionaries	**4**
15	Arrays and Datetime	**4**
Study Resources	▪ Downey, A. (2015). *Think Python: How to Think Like a Computer Scientist* (2nd ed.). O'Reilly Media, Inc. ▪ Johansson, R. (2019). *Numerical Python: Scientific Computing and Data Science Applications with Numpy, SciPy and Matplotlib* (2nd ed.). Apress. ▪ Langtangen, H. P. (2009). *Python Scripting for Computational Science* (3rd ed.). Springer Berlin Heidelberg.	

S.Y. B.Sc. Mathematics (Major)
Semester-IV
MTH-FP-241: Field Project

Credits: 2 **Contact hours : 30**

In alignment with the National Education Policy (NEP) 2020, Moolji Jaitha College (Autonomous), Jalgaon is introducing the Field Project at the undergraduate level. The NEP 2020 emphasizes holistic development, inclusivity, and integrating vocational education with academic learning, aiming to nurture socially responsible individuals. This course fosters a strong connection between education and real-world applications. These initiatives aim to bridge the gap between theoretical knowledge and practical experience, helping students develop critical thinking, problem-solving skills, and a sense of civic responsibility.

Objectives

- To provide students with practical exposure in rural and urban socioeconomic context.
- To develop students abilities to apply subject knowledge to address real world problems
- To foster critical thinking and innovative approaches to solve socioeconomic issues.

Outcomes

After completing this course, students will be able to

- Participate actively in filed projects that benefit local communities and promote sustainable development practices.
- Analyse the socio economic data using appropriate methods showcasing improved problem-solving skills, technical proficiency.
- Demonstrate the ability to apply theoretical knowledge to real-world situations effectively and exhibit communication skills.

Course structure

The course is divided in to four probable phases

I] Orientation and preparation

- Introduce to the course, objectives and expectation
- Overview of socioeconomic development issues in rural and urban context
- Training on working methodology and data collection techniques
- Review existing literature related to topic to understand the background and context.

II] Work plan and Field visit

- Visit the potential sites to get a sense of the environment and logistical requirements.
- Create a detailed project plan outlining the steps, timeline, resources needed, and roles of team members.
- Obtain necessary approvals (Ethical/ local authorities/organizations/communities)
- Gather materials and resources (recording devices, cameras, notebooks and supplies)
- Conduct Preliminary Survey, choose appropriate methods for data collection and analysis (e.g., surveys, interviews, observations).

III] Data collection and analysis

- Pilot test to identify issues with data collection.
- Collect data systematically, ensuring consistency and accuracy.
- Keep detailed records of all data (field notes, recordings, photographs etc)
- Organize and analyse the data (manual/ software)

IV] Interpretation and Reporting

- Interpret your findings in the context to objectives.

- Write and submit a comprehensive report detailing your methodology, findings, analysis, and conclusions. (Include visuals - charts, graphs, and photographs).
- Prepare a presentation to share findings with peers/ instructors/ community.

Assessment

- Field work participation, field note book, team work etc. (10 Marks)
- Data Collection and Analysis (15 Marks)
- Field project report (15 Marks)
- Presentation of Findings (10 Marks)

Examples of activities to be conducted under field projects

- **Biodiversity Survey**: Conduct a biodiversity survey in a local park or nature reserve, documenting plant and animal species.
- **Water Quality Testing**: Test water samples from different sources (e.g., rivers, lakes, ground water) for pollutants and compare results.
- **Soil Analysis**: Collect soil samples from various locations and analyse their composition and quality.
- **Wildlife Tracking**: Use camera traps or tracking devices to monitor and study the behaviour of local wildlife.
- **Urban Heat Island Effect**: Measure and map temperature differences in various parts of a city.
- **Land Use Mapping**: Create maps showing different land uses in a region and analyze changes over time.
- **Cultural Heritage Documentation**: Document and analyze local cultural heritage sites or practices.
- **Community Interviews**: Conduct interviews with community members to understand social dynamics and traditions.
- **Ethnographic Study**: Participate in and observe community events to gather ethnographic data.
- **Crop Yield Analysis**: Study the factors affecting crop yield in different fields or under different farming practices.
- **Pest Management**: Investigate the effectiveness of various pest management techniques in local farms.
- **Sustainable Farming Practices**: Evaluate the impact of sustainable farming practices on soil health and crop productivity.
- **Community Needs Assessment**: Conduct surveys and interviews to identify the needs and concerns of a community.
- **Social Network Analysis**: Study the social networks within a community to understand relationships and influence.
- **Public Health Study**: Investigate public health issues in a community, such as access to healthcare or prevalence of diseases.
- **Infrastructure Survey**: Assess the condition and effectiveness of local infrastructure, such as roads, bridges, and buildings.
- **Renewable Energy Potential**: Evaluate the potential for renewable energy sources (e.g., solar, wind) in a specific area.
- **Water Management**: Study and improve local water management systems, including irrigation and drainage.
- **Literacy Program Evaluation**: Evaluate the effectiveness of local literacy programs and suggest improvements.
- **Educational Resource Assessment**: Assess the availability and quality of educational resources in local schools.
- **Market Analysis**: Conduct a market analysis for a local business or industry.
- **Entrepreneurship Project**: Develop a business plan for a local entrepreneurial venture
- **Local History Documentation**: Research and document the history of a local site, building, or community.
- **Oral History Project**: Conduct interviews with local residents to collect oral histories and preserve community memories.

- **Archival Research**: Explore local archives to uncover historical documents and artifacts related to a specific topic or period.
- **Community Mural**: Design and create a mural in collaboration with community members that reflects local culture and history.
- **Public Art Installation**: Develop and install a public art project that engages the local community.
- **Art Exhibit Curation**: Curate an exhibit featuring works by local artists, highlighting themes relevant to the community.
- **Music Documentation**: Record and document traditional or contemporary music from the local area.
- **Community Concerts**: Organize and perform in community concerts that showcase local musical talent.
- **Community Theatre Production**: Develop and produce a play that involves community members as actors and crew.
- **Site-Specific Theatre**: Create a theatrical performance that takes place in a non-traditional venue, such as a historic site or public space.
- **Cultural Mapping**: Map cultural resources and heritage sites within the community and analyze their significance.
- **Festival Documentation**: Document and analyze local festivals or cultural events, exploring their history and impact.
- **Ethnographic Study**: Conduct an ethnographic study of a particular cultural practice or community group.
- **Public Philosophy Discussions**: Organize and facilitate public discussions on philosophical topics relevant to the community.
- **Community Documentary**: Create a documentary film about a local issue, event, or group.
- **Digital Storytelling**: Develop digital storytelling projects that capture and share local stories.
- **Language Survey**: Conduct a survey of languages spoken in the community and analyze patterns of language use and change.
- **Dialect Study**: Study and document local dialects or accents, exploring their features and origins.
- **Language Preservation**: Work with community members to document and preserve endangered languages or dialects.
- **Gentrification Impact Study**: Examine the effects of gentrification on local communities, including displacement and economic changes.
- **Crime and Safety Analysis**: Study crime patterns and perceptions of safety within a community.
- **Ritual and Festival Study**: Participate in and document local rituals or festivals to understand their social and cultural significance.
- **Migration Patterns Study**: Analyze migration patterns and their effects on both the sending and receiving communities.
- **Food and Culture Study**: Investigate the role of food in cultural practices and social interactions within a community.
- **Local Governance Analysis**: Study the structure and functioning of local government and its impact on the community.
- **Political Participation Study**: Analyze patterns of political participation and engagement within a community.
- **Public Policy Impact Assessment**: Evaluate the impact of specific public policies on local communities.
- **Election Study**: Analyze voting behavior and patterns in local elections.
- **Mental Health Survey**: Conduct surveys to assess the mental health needs and resources in a community.
- **Social Behavior Observation**: Observe and analyze social behaviors in public spaces, such as parks or markets.
- **Stress and Coping Study**: Investigate sources of stress and coping mechanisms within a community.
- **Community Support Systems**: Study the role and effectiveness of community support systems and networks.
- **Youth Development Programs**: Evaluate the impact of youth development programs on community wellbeing.
- **Educational Equity Study**: Assess disparities in educational resources and outcomes in local schools.
- **Parent and Teacher Interviews**: Conduct interviews to understand perceptions of educational quality and challenges.

- **After-School Program Evaluation**: Evaluate the effectiveness of after-school programs in supporting student development.
- **Educational Attainment Study**: Analyze factors influencing educational attainment in a community.
- **Local Economy Analysis**: Study the structure and dynamics of the local economy, including key industries and employment patterns.
- **Small Business Survey**: Conduct surveys of local small businesses to understand their challenges and successes.
- **Economic Impact of Events**: Analyze the economic impact of local events or festivals on the community.
- **Income Inequality Study**: Investigate patterns and causes of income inequality within a community.
- **Housing Affordability Analysis**: Study housing affordability issues and their impact on residents.
- **Gender Roles and Expectations**: Study gender roles and expectations within a community and their impact on individuals.
- **Women's Health Study**: Investigate issues related to women's health and access to healthcare.
- **Gender-Based Violence Survey**: Conduct surveys to understand the prevalence and impact of gender-based violence.
- **Workplace Equality Study**: Analyze gender equality in local workplaces, including pay equity and job opportunities.
- **Urban Development Projects**: Study the impact of urban development projects on local communities.
- **Public Space Usage**: Analyze how public spaces are used and perceived by different community members.
- **Transportation Study**: Investigate transportation needs and challenges within a community.
- **Green Space Analysis**: Study the availability and usage of green spaces in urban areas and their impact on residents.

S.Y. B.Sc. Mathematics (Minor)
Semester-IV
MTH-MIN-241: Theory of Differential Equations

Total Hours: 30 **Credits: 2**

Course Objectives	▪ Evaluate first order differential equations including homogeneous, exact and linear differential equations. ▪ Solve the first order and higher degree differential equations. ▪ Solve second order and higher orders linear differential equations. ▪ To know the concept of homogeneous linear differential equations.	
Course Outcomes	After successful completion of this course, students are expected to: ▪ understand basic concepts in differential equations. ▪ solve the differential equations using solvable for x, y, p and Clairaut's form. ▪ solve the linear differential equations of second and higher order. ▪ understand the method of solving the homogeneous linear differential equation.	
Unit	**Contents**	**Hours**
Unit I	**Differential Equations of First Order and First Degree:** ▪ Partial derivatives of first order and second orders ▪ Exact differential equations and Condition for exactness ▪ Integrating factor and its rules ▪ Linear differential equations ▪ Bernoulli's Differential Equation ▪ Equation reducible to linear form	**7**
Unit II	**Differential Equations of First Order and Higher Degree:** ▪ Differential equations of first order and higher degree ▪ Equation solvable for x, y and p ▪ Clairaut's form	**8**
Unit III	**Linear Differential Equations of Second and Higher Order:** ▪ Linear differential equations with constant coefficients ▪ Complementary functions ▪ Particular integrals of $f(D)y = X$, where $X = e^{ax}$, $\sin(ax)$, $\cos(ax)$, $x^n, e^{ax}V, xV$ with usual notations	**7**
Unit IV	**Homogeneous Linear Differential Equations:** ▪ Homogeneous linear differential equations (Cauchy's differential equations) ▪ Example of Homogeneous linear differential equations ▪ Equations reducible to homogeneous linear differential equations (Legendre's equations) ▪ Example of Equations reducible to homogeneous linear differential equations	**8**
Study Resources	▪ Murray, D. A. **(**1967**).** *Introductory Course in Differential Equations***.** Orient Congman (India). ▪ Simmons, G. F. **(**1972**).** *Differential Equations*, Tata McGraw Hill.	

S.Y. B.Sc. Mathematics (Minor)
Semester-IV
MTH-MIN-242: Practical on MTH-MIN-241

Total Hours: 60 **Credits: 2**

Course Objectives	▪ Evaluate first order differential equations including homogeneous, exact and linear differential equations. ▪ Solve the first order and higher degree differential equations. ▪ Solve second order and higher orders linear differential equations. ▪ To know the concept of homogeneous linear differential equations.
Course Outcomes	After successful completion of this course, students are expected to: ▪ understand basic concepts in differential equations. ▪ solve the differential equations using solvable for x, y, p and Clairaut's form. ▪ solve the linear differential equations of second and higher order. ▪ understand the method of solving the homogeneous linear differential equation.

Sr. No.	Contents	Hours
1	Partial Derivatives	4
2	Exact Differential Equations	4
3	Integrating Factor	4
4	Linear Differential Equation and Bernoulli's Equation	4
5	Equations Solvable for p	4
6	Equations Solvable for y	4
7	Equations Solvable for x	4
8	Clairaut's Equation	4
9	Complementary Function	4
10	Particular Integrable Type I	4
11	Particular Integrable Type II	4
12	Particular Integrable Type III and IV	4
13	Homogeneous linear Equations-I	4
14	Homogeneous linear Equations-II	4
15	Equations reducible to Homogeneous Linear Form	4

List of Practicals

Practical No.-1: Partial Derivatives

1. If $u = x^3z + xy^2 - 2yz$, then find $\frac{\partial u}{\partial x}, \frac{\partial u}{\partial y}$ and $\frac{\partial u}{\partial z}$ at the point (1,2,3).
2. If $= x^2y + y^2z + z^2x$, then show that $\frac{\partial u}{\partial x} + \frac{\partial u}{\partial y} + \frac{\partial u}{\partial z} = (x + y + z)^2$.
3. If $(x + y) = x^2 + y^2$, then prove that $\left(\frac{\partial u}{\partial x} - \frac{\partial u}{\partial y}\right)^2 = 4\left(1 - \frac{\partial u}{\partial x} - \frac{\partial u}{\partial y}\right)$.
4. Solve $u = e^x \sin(xy)$.
5. Solve $u = \log(x^2 + y^2 + z^2)$.

Practical No.-2: Exact Differential Equations

1. Solve $(e^x + 1)\cos x\, dx + e^y \sin x\, dy = 0$.
2. Solve $(2x - y + 1)dx + (2y - x - 1)dy = 0$.
3. Solve $(x^2 - 4xy - 2y^2)dx + (y^2 - 4xy - 2x^2)dy = 0$.
4. Solve $(2x^3 + 3y)dx + (3x + y - 1)dy = 0$.
5. Solve $\cos y - x \sin y \ \frac{dy}{dx} = \sec^2 x$.

Practical No.-3: Integrating Factor

1. Solve $x^2 y dx - (x^3 + y^3)dy = 0$.
2. Solve $(x^2 - 5xy + 7y^2)dx + (5x^2 - 7xy)dy = 0$.
3. Solve $(1 + xy)ydx + (1 - xy)xdy = 0$.
4. Solve $(xy + 2x^2y^2)ydx + (xy - x^2y^2)xdy = 0$.
5. Solve $(x^2 + y^2 + 2x)dx + 2ydy = 0$.

Practical No.-4: Linear Differential Equation and Bernoulli's Equation

1. Solve $y - x\frac{dy}{dx} = y^2 + \frac{dy}{dx}$.
2. Solve $dx + xdy = e^{-y}\sec^2 ydy$.
3. Solve $\frac{dy}{dx} + 2xy + xy^4 = 0$.
4. Solve $\frac{dy}{dx} - ytanx = -y^2 secx$.
5. Solve $\frac{dy}{dx} + ycosx = y^n sin2x$.

Practical No.-5: Equations Solvable for p

1. Solve $p^2 - 7p + 10 = 0$.
2. Solve $p - \frac{1}{p} = \frac{x}{y} - \frac{y}{x}$.
3. Solve $xyp^2 + (x^2 + xy + y^2)p + x(x + y) = 0$.
4. Solve $P^2 + 6p + 8 = 0$.
5. Solve $xyp^2 + p(3x^2 - 2y^2) - 6xy = 0$.

Practical No.-6: Equations Solvable for y

1. Solve $y + px = x^4p^2$.
2. Solve $y = 2px - p^2$.
3. Solve $4y = x^2 + p^2$.
4. Solve $p^3 + mp^2 = a(y + mx)$.
5. Solve $xp^2 - 2yp + ax = 0$.

Practical No.-7: Equations Solvable for x

1. Solve $y = 3px + 6y^2p^2$.

2. Solve $y = 2px - p^2y$.
3. Solve $x = y + p^2$.
4. Solve $x = y + a\log p$.
5. Solve $y = 2px + y^2p^3$.

Practical No.-8: Clairaut's Equation

1. Solve $y = px + a\sqrt{1+p^2}$.
2. Solve $xp^2 - yp + a = 0$.
3. Solve $p = \tan(px - y)$.
4. Solve $\sin(px)\cos y = \cos(px)\sin y + p$.
5. Solve $y = px + (p - p^2)$.

Practical No.-9: Complementary Function

1. Solve $\frac{d^2y}{dx^2} + 5\frac{dy}{dx} + 6y = 0$.
2. Solve $\frac{d^2y}{dx^2} + 13\frac{dy}{dx} + 12y = 0$. .
3. Solve $(D^3 - 3D + 4)y = 0$.
4. Solve $D^4 + 8D^2 + 16)y = 0$.
5. Solve $(D-1)^3(D^2-9)(D+3)y = 0$.

Practical No.-10: Particular Integrable Type I

1. Solve $\frac{d^2y}{dx^2} - 2\frac{dy}{dx} + y = e^x$.
2. Solve $\frac{d^2y}{dx^2} + 4\frac{dy}{dx} + 4y = e^{2x}$.
3. Solve $\frac{d^2y}{dx^2} - \frac{dy}{dx} - 6y = e^x\cosh 2x$.
4. Solve $(D^2 + 13D + 36)y = e^{-4x} + \sinh x$.
5. Solve $\frac{d^3y}{dx^3} - y = (1+e^x)^2$.

Practical No.-11: Particular Integrable Type II

1. Solve$(D^3 + 3D^2 + 2D)y = x^2$.
2. Solve $\frac{d^2y}{dx^2} - 9y = e^{2x} + x^2$.
3. Solve $\frac{d^2y}{dx^2} + 8y = x^4 + 2x + 1$.
4. Solve $(D^2 + 2D + 3)y = x - 2x^2$.
5. Solve $\frac{d^2y}{dx^2} + 4\frac{dy}{dx} + 4y = e^{-2x} + x^2$.

Practical No.-12: Particular Integrable Type III and IV

1. Solve $(D^3 + D)y = \sin 3x$.

2. Solve $(D^2+4)y = \sin 3x + e^x + x^2$.
3. Solve $(D^2-2D+1)y = x^2 e^{3x}$.
4. Solve $(D^2-4D+3)y = e^x \cos 2x$.
5. Solve $(D^2-1)y = x^2 \sin x$.

Practical No.-13: Homogeneous linear Equations-I

1. Solve $x^2\frac{d^2y}{dx^2} + x\frac{dy}{dx} - 4y = 0$.
2. Solve $x^2\frac{d^2y}{dx^2} - 3x\frac{dy}{dx} + 4y = 2x^2$.
3. Solve $\frac{d^2y}{dx^2} - \frac{1}{x}\frac{dy}{dx} + \frac{y}{x^2} = \frac{2\log z}{x^2}$.
4. Solve $x^2\frac{d^2y}{dx^2} - x\frac{dy}{dx} - 3y = x^2\log x$.
5. Solve $x^2\frac{d^2y}{dx^2} - 3x\frac{dy}{dx} + 5y = x^2\sin(\log x)$.

Practical No.-14: Homogeneous linear Equations-II

1. Solve $x^2\frac{d^2y}{dx^2} + 4x\frac{dy}{dx} + 2y = e^x$.
2. Solve $x^2\frac{d^2y}{dx^2} - x\frac{dy}{dx} + 2y = x\log x$.
3. Solve $\frac{d^2y}{dx^2} - \frac{2}{x}\frac{dy}{dx} - \frac{4y}{x^2} = x^2$.
4. Solve $x^2\frac{d^2y}{dx^2} - 4x\frac{dy}{dx} + 6y = x^2\log x$.
5. Solve $x^2\frac{d^2y}{dx^2} - 3x\frac{dy}{dx} + 3y = x^2$.

Practical No.-15: Equations reducible to Homogeneous Linear Form

1. Solve $(2x+1)^2\frac{d^2y}{dx^2} - 2(2x+1)\frac{dy}{dx} - 12y = 6x$.
2. Solve $(1+x)^2\frac{d^2y}{dx^2} + (1+x)\frac{dy}{dx} + y = 4\cos(\log(1+x))$.
3. Solve $(1+x)^4\frac{d^3y}{dx^3} + 2(1+x)^3\frac{d^2y}{dx^2} - (1+x)^2\frac{dy}{dx} + (1+x)y = x^2$.
4. Solve $(3x+2)^2\frac{d^2y}{dx^2} + 3(3x+2)\frac{dy}{dx} - 36y = 3x^2 + 4x + 1$.
5. Solve $(1+2x)^2\frac{d^2y}{dx^2} - 6(1+2x)\frac{dy}{dx} + 16y = 8(1+2x)^2$.

S.Y. B.Sc. Mathematics (Open Elective)
Semester-IV
MTH-OE-241: Mathematics for Competitive Exams-IV

Total Hours: 30 **Credits: 2**

Course Objectives	▪ The main aim of introducing Mathematics for Competitive Examinations-IV for students is to develop the skill to meet the competitive examinations for better job opportunities. ▪ Find the volume and surface area of the different geometrical figures. ▪ Apply the principles of trigonometry to solve problems related to heights and distances. ▪ Attract the students to attain the mathematical problems and create interest in students about mathematics.	
Course Outcomes	After successful completion of this course, students are expected to: ▪ Develop the ability to use basic trigonometric ratios to find unknown distances or heights in right-angled triangles. ▪ Develop analytical and logical thinking by evaluating number patterns ▪ Develop the ability to extract and interpret information from tables for solving problems. ▪ Apply bar graphs to real-life situations, such as analyzing survey results, performance comparisons, or market trends.	
Unit	**Contents**	**Hours**
Unit I	**Volume and Surface Area** ▪ Cuboid and Cube ▪ Cylinder ▪ Cone ▪ Sphere	**7**
Unit II	**Heights, Distances, Odd Man Out and Series** ▪ Trigonometrical Identities ▪ Values of T-ratios ▪ Angle of Elevation ▪ Angle of Depression ▪ Odd Man Out and Series	**8**
Unit III	**Tabulation and Bar Graphs** ▪ Tabulation ▪ Bar Graphs	**7**
Unit IV	**Pie Chart and Line Graphs** ▪ Pie Chart ▪ Line Graphs	**8**
Study Resources	▪ Aggarwal, R. S. (2018). *Quantitative Aptitude for Competitive Examinations* (Revised ed.). S. Chand and Co. Ltd, New Delhi. (Section–I : Art.25, Art.34-39.) ▪ Praveen, R. V. *Quantitative Aptitude and Reasoning*. PHI publishers. ▪ *Quantitative Aptitude: Numerical Ability* (Fully Solved) Objective Questions. Kiran Prakashan, Pratogitaprakasan, Kic X, Kiran Prakasan publishers. ▪ Guha, A. *Quantitative Aptitude for Competitive Examination*. Tata Mc Graw hill publications.	

Skills acquired and Job opportunity for the Mathematics students

Skills acquired:
The curriculum is designed to inculcate basic principles of mathematical methods and analysis to apply in various fields of scientific research. The curriculum contains a wide variety of mathematical topics like topology, linear algebra, differential equations, numerical analysis, transformations, operations research, fluid mechanics, functional analysis and mathematical methods. Further the following skills are developed on successful completion:

- critical thinking
- problem solving
- analytical thinking
- quantitative reasoning
- ability to manipulate precise and intricate ideas
- construct logical arguments and expose illogical arguments
- time management
- teamwork
- independence

Job opportunity:
The designed curriculum offers job opportunities like:

- mathematics teacher
- Scientist
- Programmer
- Software professional
- Banker
- Accountant.
- Actuary
- Data analyst
- Engineer
- Investment manager
- Research leading to Ph. D. degree
- Self entrepreneurship