ST. ALBERT'S COLLEGE (AUTONOMOUS) ERNAKULAM

Affiliated to Mahatma Gandhi University, Kottayam, Kerala

SYLLABUS FOR UNDERGRADUATE PROGRAMMES

BACHELOR OF SCIENCE (HONOURS) IN MATHEMATICS

SACA – UGP

(WITH EFFECT FROM 2024 ADMISSION)

Syllabus of BSc Mathematics

Prepared by the Board of Studies on 21st August 2023

Dr. Sabu M.C.

Chairman, Board of Studies

Approved by the Academic Council on 14th March 2024

Dr. Bijoy V.M., Principal

Chairman, Academic Council

Approved by the Governing Council on 27th March 2024

Fr. Dr. Antony Thoppil

Chairman, Governing Council

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f.	**Meritorious alumnus:**		
1/14	Navaneetha M R	Post Doctoral Fellow, TIFR	MSc, Ph D
g.	**Co-opted members as special invitees:**		
	Co-opted Special Experts from outside:		
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2/19	Smt. Jeema Jose	Assistant Professor, Department of Mathematics, St. Albert's College (Autonomous), Ernakulam	M Phil, NET
3/20	Dr. Veena V S	Assistant Professor in Mathematics, Department of Data Analytics and Mathematical Science, JAIN (deemed-to-be university), Kochi	M Sc, NET, Ph D
4/21	Dr. Soubhagya S Prabhu	Assistant Professor in Statistics, Rajagiri School of Social Sciences (Autonomous), Kalamassery	M Sc, Ph D

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PREFACE

In alignment with the National Educational Policy, the Higher Education Council has launched a new curriculum that promotes multidisciplinary learning. This curriculum empowers students to choose their undergraduate subjects freely, offering a wider range of educational options.

This curriculum offers a comprehensive syllabus that integrates a vast array of knowledge and technological advancements. It prioritizes skill development, research, innovation, and value-added components to equip students with the professional and contemporary skills required for modern education.

The revised syllabus is the result of a collaborative effort by a dedicated team of subject experts in Mathematics assembled by the M G University. We extend our sincere gratitude to the Board of Studies in Mathematics at M G University for their invaluable contributions in developing a new Four-Year Degree Honors Programme curriculum.

In the curriculum of SACA-UGP (Honours) in Mathematics, we are currently incorporating key elements of the MG University Syllabus, along with signature courses developed by the Board of Studies in Mathematics & Statistics at St. Albert's College (Autonomous), Ernakulam. We would like to express our gratitude to the University Nominee, Subject Experts, Industrial Experts, Alumni, and other stakeholders for their valuable contributions.

Dr. Sabu M.C.

Chairman, BoS Mathematics & Statistics

THE ST. ALBERTS COLLEGE (AUTONOMOUS) UNDERGRADUATE PROGRAMMES (HONOURS) REGULATIONS, 2024

SACA-UGP (Honours)

PREAMBLE

The University Grants Commission (UGC) has issued the Curriculum and Credit Framework for Undergraduate Programmes 2023 (CCFUP) which would provide a flexible choice-based credit system, multidisciplinary approach, multiple entry and exit options, and establish three Broad Pathways, (a) 3-year UG Degree, (b) 4-year UG Degree (Honours), and 4-year UG Degree (Honours with Research).

The Kerala Higher Education Reforms Commission has recommended a comprehensive reform in the undergraduate curriculum for the 2023-24 academic year, adopting 4-year undergraduate programmes to bring Kerala's undergraduate education at par with well acclaimed universities across the globe.

The Kerala State Curriculum Committee for Higher Education has been constituted and have proposed a model Kerala State Higher Education Curriculum Framework (KSHECF) for Undergraduate Education. Further, an Executive Committee and various sub committees were constituted for the implementation of the Regulations. Further, MGU has framed the Rules and Regulations based on this namely: THE MAHATMA GANDHI UNIVERSITY UNDERGRADUATE PROGRAMMES (HONOURS) REGULATIONS, 2024 {MGU-UGP (Honours)} under the New Curriculum and Credit Framework, 2024. Being an Autonomous college affiliated to MG University, St. Albert's College is adopting all the major components of MGU UGP (Honours) 2024 in the title SACA-UGP (Honours) to our UG curriculum from the academic year (2024-25) onwards.

1. Short Title and Commencement

a) The Regulations will be called as "**THE ST. ALBERT'S COLLEGE (AUTONOMOUS) UNDERGRADUATE PROGRAMMES (HONOURS) REGULATIONS, 2024 {SACA-UGP (Honours)}"** under the New Curriculum and Credit Framework 2024.

b) These Regulations will come into effect from the academic year 2024-2025 and will have prospective effect.

2. Scope, Application

a) These Regulations shall apply to all undergraduate programmes (except B. Voc.) of ST. ALBERT'S COLLEGE (AUTONOMOUS) for the Admissions commencing in the academic year 2024-2025.

b) Every programme conducted under the SACA-UGP shall be monitored by the SACA-UGP Academic Committee (Academic Council).

3. Definitions

Unless context otherwise required,

i. FYUGP means Four Year Undergraduate Programme.

ii. Academic Year: Two consecutive (one odd and one even) semester followed by a vacation in one academic year.

iii. Academic Coordinator/Nodal Officer: Academic Coordinator/Nodal Officer is a faculty nominated by the College Council to co-ordinate the effective conduct of the FYUGP including Continuous Comprehensive Assessment (CCA) undertaken by various departments within the College. She/ he/ they shall be the convenor for the College level Academic Committee.

iv. Academic Week: A unit of five working days in which the distribution of work is organized, with five contact hours of one-hour duration on each day.

v. Academic Credit: A unit by which the course work is measured. It determines the number of hours of instructions required per week in a semester. It is defined both in terms of student efforts and teacher's efforts. A course which includes one hour of lecture or tutorial or minimum 2 hours of lab work/ practical work/ field work per week is given one credit hour. Accordingly, one credit is equivalent to one hour of lecture or tutorial or two hours of lab work/ practical work/ field work/ practicum and learner engagement in terms of course related activities (such as seminar preparation, submitting assignments, group discussion, recognized club-related activities etc.) per week. Generally, a one credit course in a semester should be designed for 15 hours lecture/ tutorials or 30 hours of practical/ fieldwork/ practicum and 30 hours learner engagement.

vi. Academic Bank of Credits (ABC): An academic service mechanism as a digital/ virtual entity established and managed by Government of India to facilitate the learner to become its academic account holders and facilitating seamless learner mobility, between or within degree-granting Higher Education Institutions (HEIs) through a formal system of credit recognition, credit accumulation, credit transfers and credit redemption to promote distributed and flexible process of teaching and learning. This will facilitate the learner to choose their own learning path to attain a Degree/ Diploma/ Certificate, working on the principle of multiple entry and exit, keeping to the doctrine of anytime, anywhere, and any level of learning.

vii. Credit Accumulation: The facility created by ABC in the Academic Credit Bank Account (ABA) opened by the learner across the country in order to transfer and consolidate the credits earned by them by undergoing courses in any of the eligible HEIs.

viii. Credit Recognition: The credits earned through eligible/ partnering HEIs and transferred directly to the ABC by the HEIs concerned.

ix. Credit Redemption: The process of commuting the accrued credits in the ABC of the learner for the purpose of fulfilling the credits requirements for the award of various degrees. Total credits necessary to fulfil the criteria to get a degree shall be debited and deleted from the account concerned upon collecting a degree by the learner.

x. Credit Transfer: The mechanism by which the eligible HEIs registered with ABC are able to receive or provide prescribed credits to individuals registered with ABA in adherence to the UGC credit norms for the course(s) registered by the learner in any HEIs within India.

xi. Credit Cap: Maximum number of credits that a student can take per semester, which is restricted to 30.

xii. Continuous Comprehensive Assessment (CCA): The mechanism of evaluating the learner by the course faculty at the institutional level.

xiii. End Semester Evaluation (ESE): The mechanism of evaluating the learner at the end of each semester.

xiv. Audit Course: A course that the learner can register without earning credits and is not mandatory for completing the SACA-UGP. The student has the option not to take part in the CCA and ESE of the Audit Course. If the student has 75% attendance in an Audit Course, he/ she/ they are eligible for a pass in that course, without any credit (zero-credit).

xv. Courses: Refer to the papers which are taught and evaluated within a programme, which include lectures, tutorials, laboratory work, studio activity, fieldwork, project work, vocational training, viva, seminars, term papers, presentations, assignments, self-study, group discussion, internship, etc., or a combination of some of these elements.

xvi. Choice Based Credit System (CBCS) means the system wherein students have the option to select courses from the prescribed list of courses.

xvii. College-level Academic Committee: Is a committee constituted for the FYUGP at the College level comprising the Principal as the Chairperson, the Academic Co-ordinator/ Nodal Officer as its convenor.

xviii. Academic Co-ordinator/ Nodal Officer: A senior faculty member nominated by the College Council.

xix. Course Faculty: A faculty member nominated by the Head of the Department shall be in charge of offering a particular course in a particular semester of FYUGP.

xx. Department means any teaching department in a college offering a course of study approved by the Governing body and statutory bodies of the College.

xxi. Senior Faculty Advisor (SFA) is a faculty nominated by a Department Council to coordinate all the necessary work related to FYUGP undertaken in that department, including the Continuous Comprehensive Assessment.

xxii. Department Council means the body of all teachers of a department in a college.

xxiii. Faculty Advisor (FA) means a teacher from the parent department nominated by the Department Council to advise students in academic matters.

xxiv. Graduate Attributes means the qualities and characteristics to be obtained by the graduates of a programme of study at the College, which include the learning outcomes related to the disciplinary areas in the chosen field of learning and generic learning outcomes. The graduate attributes for its programmes will be specified.

xxv. Programme means the entire duration of the educational process including the evaluation leading to the award of a degree.

xxvi. Programme Pathway: Combination of courses that can be chosen by a student that give options to pursue interesting and unconventional combinations of courses drawn from different disciplinary areas, like the sciences and the social sciences/ humanities. The pathways could be in terms of major- minor options with different complementary/allied disciplines.

xxvii. Regulatory Body means University Grants Commission (UGC), All India Council for Technical Education (AICTE), National Council for Teacher Education (NCTE), Medical Council of India (MCI), Pharmacy Council of India (PCI), Indian Council for Agricultural Research (ICAR), Bar Council of India, Council of Architecture, National Assessment and Accreditation Council (NAAC) and

National Board of Accreditation (NBA) etc.

xxviii. Signature Courses: Signature courses are the specialized Discipline Specific Elective courses or skill enhancement/value addition courses offered by the regular/ ad hoc/visiting/ emeritus/ adjunct faculty member of a particular Department with the prior recommendation of the BoS and the approval of Academic Council of the College.

xxix. Letter Grade or simply 'Grade' in a course is a letter symbol (O, A+, A, B+, B, C, P, F, and Ab). Grade shall mean the prescribed alphabetical grade awarded to a student based on their performance in various examinations. The Letter grade that corresponds to a range of CGPA.

xxx. Grade Point: Each letter grade is assigned a 'Grade point' (G) which is an integer indicating the numerical equivalent of the broad level of performance of a student in each course. Grade Point means point given to a letter grade on 10-pointscale.

xxxi. Semester Grade Point Average (SGPA) is the value obtained by dividing the sum of credit points obtained by a student in the various courses taken in a semester by the total number of credits in that semester. SGPA shall be rounded off to two decimal places. SGPA determines the overall performance of a student at the end of a semester.

xxxii. Credit Point (P) of a course is the value obtained by multiplying the grade point (G) by the credit (C) of the course: $P = G \times C$

xxxiii. Cumulative Grade Point Average (CGPA) is the value obtained by dividing the sum of credit points in all the semesters earned by the student for the entire programme by the total number of credits in the entire programme and shall be rounded off to two decimal places

xxxiv. Grade Card means the printed record of students' performance, awarded to them.

xxxv. Words and expressions used and not defined in this regulation but defined in the M. G. University Act and Statutes, and College handbook shall have the meaning assigned to them in the Act and Statutes and handbook

4. Features and Objectives of SACA-UGP 2024

The features and objectives of the SACA-UGP 2024 shall be:

a) The features, meaning, and purpose of FYUGP shall be as stipulated by the UGC and as adapted by the Kerala State Higher Education Curriculum Framework (KSHECF) and MGU-UGP (Honours) for undergraduate education.

b) The practice of lateral entry of students to various semesters exists, but an exit with a Degree shall be awarded only upon successful completion of 133 credits as per the conditions stipulated in this regulation.

c) FYUGP shall have three Broad Pathways, (a) 3-year UG Degree, (b) 4-year UG Degree (Honours), and (c) 4-year UG Degree (Honours with Research).

d) Students who choose to exit after 3 years shall be awarded UG Degree in their respective Discipline/ Disciplines after the successful completion of the required minimum Courses with 133 credits.

e) A 4-year UG Degree (Honours) in the Discipline/ Disciplines shall be awarded to those who complete the SACA-UGP with a specific number of Courses with 177 credits including 12 credits from a capstone level graduate project/dissertation. Those students who are not doing capstone project shall do three courses at the level 400 or above or three vocational training courses or internships for 12 credits.

f) Students who acquire minimum 75% in their graduation (upto 6^{th} semester) are eligible for Honours with Research Programme. However, if necessary, College may conduct screening test for the honours with research programme in accordance with University and College Regulations time to time.

g) 4-year UG Degree (Honours with Research): Students who aspire to pursue research as a career may opt for 4-year UG Degree Honours with Research stream under FYUGP with a specific number of Courses with 177 credits including 12 credits from a research project in their major discipline.

h) The recognized research departments or departments with at least two faculty members having PhD shall offer the Honours with Research programme. Minimum 2 students (mentees) should be allotted to a faculty member (Mentor).

i) Students who have chosen the honours with research stream shall do their entire fourth year under the mentorship of a mentor.

j) The mentor shall prescribe suitable advanced level/capstone level courses for a minimum of 20 credits to be taken within the institutions along with the courses on research methodology, research ethics, and research topic-specific courses for a minimum of 12 credits which may be obtained either within the institution or from other recognized institutions, including online and blended modes. Students shall also be allowed to pursue these three courses of 12 credits from suitable interdisciplinary/ transdisciplinary/ multidisciplinary/ vocational areas of their choice.

k) Students who have opted for the honours with research should successfully complete a research project under the guidance of the mentor and should submit a research report for evaluation. They need to successfully defend the research project to obtain 12 credits under a faculty member of the University/ College/Recognized Research Institute. The research shall be in the Major/ allied discipline.

l)The research outcomes of their project work may be published in peer-reviewed journals or presented at conferences or seminars or patented.

m) The proposed FYUGP curriculum comprises three broad parts: a) Foundation Components, b) Discipline Specific Pathway components (Major/ Minor), and c) Discipline Specific Capstone Components.

n) The Foundation component of the FYUGP shall consist of a Set of General Foundation Courses and a Set of Discipline Specific Foundation Courses.

o) General Foundation Courses shall be grouped into 4 major baskets as Ability Enhancement Courses (AEC), Skill Enhancement Courses (SEC), Value Addition Courses (VAC), and Multi-Disciplinary Courses (MDC).

p) Ability Enhancement Courses shall be designed specifically to achieve competency in English, other languages as per the student's choice with special emphasis on language and communication skills.

q) English or other language courses shall be designed to enable the students to acquire and demonstrate the core linguistic skills, including critical reading, academic and expository writing skills as well as the cultural and intellectual heritage of the language chosen. Separate courses will be designed for Science, Humanities and Commerce streams.

r) Multi-Disciplinary Courses (MDC) shall be so designed as to enable the students to broaden their intellectual experience by understanding the conceptual foundations of Science, Social Sciences, Humanities, and Liberal Arts. Students shall not be eligible to take the MDC in the same discipline that they have studied during their Plus Two. Third semester MDC can be Kerala specific content. Each BoS can prepare basket of courses under MDC.

s) Skill Enhancement Courses (SEC) shall be designed to enhance 21st century workplace skills such as creativity, critical thinking, communication, and collaboration.

t)Discipline Specific Courses shall include Discipline Specific Pathway Courses, both Major and Minor streams, enabling students to gain basic knowledge in the chosen discipline.

u) Discipline Specific Foundation Courses shall focus on foundational theories, concepts, perspectives, principles, methods, and critical thinking essential for taking up advanced/ Capstone Courses. Practical courses shall be included in discipline specific foundation courses.

v) The curriculum of the SEC should be designed in a manner that at the end of year-1, year-2, year-3, and year-4 students are able to meet the level descriptors for levels 5, 6, 7, and 8 of the UGC Guidelines on National Skills Qualifications Framework (NSQF).

w) Value Addition Courses (VAC) shall be so designed as to empower the students with personality development, perspective building, and self-awareness.

x) Discipline Specific Pathway Components (Major/Minor) shall provide the students with an opportunity to pursue in-depth study of a particular subject or discipline and develop competency in that chosen area, which includes Discipline Specific Core (DSC) courses and Discipline Specific Elective (DSE) courses as Major and Minor courses.

y) Major components consist of three types: Discipline Specific Core or the Discipline Specific Elective Courses, and the research/laboratory/fieldwork.

z) Minor Courses can be selected from any discipline. A student who completes 12 credits in a particular stream will be eligible for a minor.

aa) Students who complete a sufficient number of Courses in a discipline or an interdisciplinary area of study other than their chosen Major shall qualify for a Minor in that discipline or in a chosen interdisciplinary area of study.

bb) Major Components shall be the main focus of study. By selecting a Major, the student shall be provided with an opportunity to pursue an in-depth study of a particular discipline.

cc) Each Board of Studies (BoS) shall identify specific Courses or baskets of Courses towards Minor Course credits. Students shall have the option to choose Courses from disciplinary/ interdisciplinary minors and skill-based courses related to a chosen programme.

dd) Students can opt for a change of Major at the end of the second semester to any Minor discipline studied among the foundation level courses. Students can also opt for a change of Major at the end of the second semester to any MDC.

ee) Students should opt their 5^{th} and 6^{th} semester VAC and SEC from their Major disciplines only.

ff) Course cum Credits Certificate: After the successful completion of a semester, this certificate is essential as proof for re-entry to another institution. This will help the learner for preserving the credits in the Academic Bank of Credits.

gg) The Advanced Level/ Capstone Level Courses shall be designed in such a manner as to enable students to demonstrate their cumulative knowledge in their main field of study, which shall include advanced thematic specialization or internships or community engagement or services, vocational or professional training, or other kinds of work experience.

hh) Advanced/ Capstone level Major Specialization shall include Courses focused on a specific area of study attached to a specific Major, which could be an Elective Course. They shall include research methodology as well.

ii) The student has the option to register for and attend a course without taking part in the CCA and ESE of that course. Such a course is called the Audit Course. If the student has 75% attendance in an Audit Course, he/she/they is eligible for a pass in that course, without any credit (zero-credit). The Audit Course will be recorded in the final grade card of the student.

jj) All students shall undergo Summer Internship or Apprenticeship in a Firm, Industry or Organization; or Training in labs with faculty and researchers or other Higher Education Institutions (HEIs) or Research Institutions. A separate guideline for Internship Programmes will be published.

kk) Students will be provided the opportunities for internships with local industries, business organizations, agriculture, health and allied sectors, Local Government institutions (such as panchayats, municipalities), State Planning Board, State Councils/Boards, Research Institutions, Research Labs, Library, elected representatives to the parliament/state assembly/panchayath, media organizations, artists, crafts persons etc. These opportunities will enable the students to actively engage with the practical aspects of their learning and improve their employability.

ll) The College will assist in providing opportunities for field-based learning/minor Projects enabling them to understand the different socio-economic and development-related issues in rural and urban settings. The College will assist in providing the students with opportunities for Community engagement and services, exposing them to socio-economic issues to facilitate theoretical learning in real-life contexts.

mm) Additional Credits will be awarded for those who actively participate in Social Activities, which may include participation in National Service Scheme (NSS), Sports and Games, Arts, participation in University/ college union related activities (for respective elected/nominated members), National Cadet Corps

(NCC), adult education/literacy initiatives, mentoring school students, and engaging in similar social service organizations that deemed appropriate to the College.

nn) Grace marks shall be awarded to a student for meritorious achievements in co-curricular activities (in Sports/ Arts/ NSS/ NCC etc.). Such a benefit is applicable in the same academic year spreading over two semesters, in which the said meritorious achievements are earned. The Academic Council will decide from time to time the eligibility and other rules of awarding the grace marks.

oo) Options will be made available for students to earn credit by completing quality-assured remote learning modes, including Online programmes offered on the Study Webs of Active-Learning for Young Aspiring Minds (SWAYAM) or other Online Educational Platforms approved by the competent body from time to time.

pp) Students shall be entitled to gain credits from courses offered by other recognized institutions directly as well as through distance learning.

qq) For the effective operation of the FYUGP, a system of flexible academic transaction timings shall be implemented for the students and teachers.

rr) Specialization: Student will have the option to achieve specialization within their Major by securing 12 credits from a disciplinary/interdisciplinary area. By choosing atleast 3 courses from discipline specific elective basket under a chosen field (preferably one from 200 level course and two 300 level courses) student will be awarded specialization in that particular area of study. Each student will have the option to achieve two specializations at a time from the institution.

5. Eligibility for Admission and Reservation of Seats

i. The eligibility for admissions and reservation of seats for various FYUG Degree Programmes shall be in accordance with the norms/ rules made by the Government/University/College from time to time.

ii. No student shall be eligible for admission to FYUG Degree Programmes in any of the disciplines unless he/she/they have successfully completed the examination conducted by a Board/University at the Plus Two level of schooling or its equivalent.

iii. Students shall be admitted and enrolled in the respective programmes solely based on the availability of the academic and physical facilities within the institution. The College shall provide all students with a brochure detailing the Courses offered by the various departments under the various Programmes and the number of seats sanctioned for each Programme.

iv. During the time of admission each student may be provided with a unique higher education student ID which may be linked with the Aadhar number of the students so that his ID can be transferred if required to other higher education institutions as well.

v. The students at the end of second semester may be permitted to change their major programme of study to any course/ institution/ university across the state. Based on the availability of seats and other facilities, the students may be permitted to opt any discipline which he/she/they had studied during the first two semesters as Discipline Specific Foundation courses/ Multidisciplinary Foundation courses. If ranking is required, it will be in the order of the highest-grade points secured in the discipline to which the switching of Major is sought.

vi. Students shall be allowed to change their major programmes, if required, to a maximum of 10% of the sanctioned strength of that particular programmes depending upon the academic and infrastructural facilities available in the Institution.

vii. Depending upon the availability of academic and infrastructural facilities, the Institution may also admit a certain number of students who are registered for particular programmes in each semester by transfer method, if required, from other Institutions subject to conditions as may be issued by the University.

viii. A student who has already successfully completed a First-Degree Programme and is desirous of and academically capable of pursuing another First-Degree Programme may also be admitted with the prior approval of the University as per the conditions regarding programme requirements specified by the University.

ix. A Student can also be admitted for an additional major/ second major/ additional minor and on completion of the required credits he/she/they can be awarded a second major/ additional major/ minor. He/she/they may be exempted from minor pathway and general foundation course requirement.

x. The HEIs can also enrol students in certain courses as per their choice depending upon the availability of infrastructure and other academic facilities from other recognized HEIs who are already registered for a particular programme there either through regular/online/distance mode irrespective of the nature of programme (Govt/ Aided/ Self- finance/ Autonomous). On successful completion of the course the credits may be transferred through the Academic Bank of Credit (ABC), against the unique higher education ID provided by the College at the time of admission.

6. Academic Monitoring and student Support

The academic monitoring and student support shall be in the following manner, namely

a) College should appoint a Senior Faculty member as Academic Co-ordinator/Nodal officer for the smooth conduct of FYUGP.

b) Advisory System: There shall be one Senior Faculty Advisor (SFA) for each department and one Faculty Advisor (FA) for 20 to 30 students of the class to provide advice in all relevant matters. The Head of the Department, in consultation with the SFA, shall assign FA for each student.

c) The documents regarding all academic activities of students in a class shall be kept under the custody of the FA/SFA.

d) All requests/ applications from a student or parent to higher offices are to be forwarded/recommended by FA/SFA.

e) Students shall first approach their FA/ SFA for all kinds of advice, clarifications, and permissions on academic matters.

f) It is the official responsibility of the institution to provide the required guidance, clarifications, and advice to the students and parents strictly based on the prevailing academic regulations.

g) The SFA shall arrange separate or combined meetings with FA, faculty members, parents, and students as and when required and discuss the academic progress of students.

h) The FA/SFA shall also offer guidance and help to solve the issues on academic and non-academic matters, including personal issues of the students.

i)Regular advisory meetings shall be convened immediately after the commencement of the semester and immediately after announcing the marks of the Continuous Comprehensive Assessment (CCA).

j)The CCA related results shall be uploaded on the College portal only after displaying the same on the department notice board/other official digital platforms of the college at least for two working days.

i. Any concern raised by the students regarding CCA shall be looked into in the combined meetings of advisors, HoD, course faculty, and the students concerned.

ii. If the concerns are not resolved at the advisor's level, the same can be referred to the properly constituted department-level grievance redressal committees

iii. The HOD shall ensure the proper redressal of the concerns raised by the students regarding CCA.

k) If the students raise further concerns about the issue, the Principal shall refer the issue to the College-level grievance committee with proper documents and minutes of all the committees.

l) The FA/SFA shall be the custodian of the minutes and action taken reports of the advisory meetings. The SFA shall get the minutes and action taken reports of advisory meetings approved by the Head of Department and the Principal. It shall be the duty of the HoD and the Principal to produce them before the Governing body of the College as and when required.

m) The Principal shall inform/forward all regulations, guidelines, communications, announcements, etc. issued by the University regarding student academic and other matters to the HODs/ SFA for information and timely action.

n) It shall be the official responsibility of the Principal to extend the required administrative and financial support to the HODs, SFAs and FAs to arrange necessary orientation programmes for students regarding student counselling, the prevailing College norms, regulations, guidelines and procedures on all academic and other College related matters.

o) An integrated educational planning and administration software will be made available by the College to manage the academic information of all students. Which include student admissions and registration, managing student personal and academic information, course registrations, attendance management, all process related to assessments including regular & online examinations, grading, publishing of results, supplementary examinations, LMS, stakeholders' feedback, etc.

p) Faculty, staff, students, and parents shall be allowed to access this software system over a highly secure authenticated mechanism from within the campus and outside the campus.

7. Course Registration

a) Each department shall publish well in advance the relevant details of courses offered, such as the name, academic level, expected outcomes, time slot, and course faculty members.

b) Students shall be allowed to visit and interact with respective faculty members during the first week of each semester, to gather more information about the courses and the availability of seats.

c) Based on consultations and advice from the faculty adviser, each student shall complete course registration within one week from the commencement of each semester.

d) The number of credits that a student can take in a semester is governed by the provisions in these Regulations, subject to a minimum of 16 and a maximum of 30 Credits.

e) A student can opt out of a Course or Courses registered, subject to the minimum Credit/ Course requirement, if he/she/they feel that he/she/they has registered for more Courses than he/she/they can handle, within 30 days from the commencement of the semester. An option can be given to the student to convert this course as audit course if he/she/they wishes to do so.

f) The college shall publish a list of the students registered for each course including audit course, if any, along with the chosen Programmes, repeat/reappearance courses, if any, and shall forward the same to the university.

g) The higher education institutions shall admit candidates not only for programmes, but also for courses.

8. Re-admission and Scheme Migration

a) Students who opt out before the completion of the third year shall be provided with a 'Course cum Credits Certificate' after the successful completion of a semester as proof for re-entry to another institution.

b) Students who have successfully completed a particular programme pathway maybe permitted to take an additional minor or second major.

c) Those students who are opting for a second major are eligible for getting certain credit transfer/ credit exemption from their previous minor programs of study, subject to the prior recommendation of the BoS that, those credits are relevant for the present major programme of study.

9. Duration of Programmes, Credits Requirements and Options

a) Students will be offered the opportunity to take breaks during the programme and resume after the break, but the total duration for completing the FYUG programme shall not exceed 7 years.

b) Students who wish to complete the undergraduate programmes faster may do so by completing different courses equivalent to the required number of credits and fulfilling all other requirements in N-1 semesters, where N is the number of semesters in the FYUGP.

c) Provided further that the students may complete the undergraduate programme in slower pace, they may pursue the three years or six semester programme in 4 to 5 years (8 to 10 semesters), and four years, or eight semester programme in 5 to 6 years (10 to 12 semesters) without obtaining readmission.

d) For students who crossed 6 semesters at a slower space, the requirement of 16 credits per semester from the institutions where they enrolled may be relaxed.

10. Credit Structure

The proposed number of credits per course and the credit distribution of them for the FYUG Programmes are given below-

a) An academic year shall consist of 200 working days; one semester consists of 90 working days; and an academic year consists of two semesters.

b) Ten working days in a semester shall be used for extracurricular activities. One semester consists of 18 weeks with 5 working days per week. In each semester, 15 days (3 weeks) should be kept aside for End Semester Evaluation (ESE) and CCA.

c) The maximum number of available weeks for curriculum transactions should be fixed at 15 in each semester. A minimum of 5 teaching or tutorial hours could be made available for a day in a 5-day week.

d) A course that includes one hour of lecture/ tutorial or two hours of lab work/practical work/fieldwork/practicum per week is given one credit hour.

e) One credit in a semester should be designed for 15 hours of lectures/ tutorials or 30 hours of lab work/ practical work/ field work/ practicum and 30 hours of learner engagement in terms of course-related activities such as seminar preparation, assignment submission, etc.

f) A one-credit seminar or internship or studio activities or field work/ projects or community engagement and service will have two-hour engagements per week (30 hours of engagement per semester).

g) A course can have a combination of Lecture (L)/ Tutorial (T)/ Practicum or Practical (P)/ & Others (O) credits.

h) Minimum credit for one Course should be 2 (Two), and the maximum credit should be 4 (Four).

i) All Discipline Specific Major/Minor Courses shall be of 4 (Four) credits.

j) For all Discipline Specific Major/Minor Courses, there may be practical/ practicum.

k) All Courses under the Multi-Disciplinary, Ability Enhancement, Value Addition and Skill Enhancement categories are of 3 credits. Practical/Practicum credits can also be included in this category.

l) Summer Internship, Apprenticeship, Community Outreach activities, etc. may require sixty hours (or as appropriate) of engagement for acquiring one credit.

m) A student shall be able to opt for a certain number of extra credits over and above the requirements for the award of a degree.

n) Maximum number of credits that a student can earn per semester shall be restricted to 30. Hence, a student shall have the option of acquiring credits to a maximum of 180 credits for a 3-year (6-semester) UG programmes and 240 credits for a 4-year (8-semester) programmes.

o) Each faculty member shall offer a maximum of 16 credits per semester. However, those who are offering both practical and theory courses shall offer a maximum of 12-16 credits per semester.

p) For a four-credit theory course, 60 hours of lecture/ tutorial class shall be assured as a mandatory requirement for the completion of that course.

11. **Course Structure of the SACA-UGP Programmes**

The SACA-UGP consists of the following categories of courses and the minimum credit requirements for pathway option-one shall be as follows:

Sl. No.	Categorization of Courses for all Programmes	Minimum Number of Credit Required	
		3-yearUG	**4-yearUG**
1	Major	68	88
2	Minor	24	24+12*
3	Multi-Disciplinary Courses (MDC)	9	9
4	Skill Enhancement Courses (SEC)	9	9
5	Ability Enhancement Courses (AEC)	12	12
6	Value Addition Courses (VAC)	9	9
7	Summer Internship, field-based learning etc.	2	2
8	Research Project/Dissertation		12**
	Total Credits	**133**	**177**

*The students can acquire advanced/capstone level courses with 12 credits from their DSC/ DSE/ Minor courses depending upon their pathway choice. The Minor courses can be of level 300 or above.

** The students pursuing the 4-year honours with research have to complete a capstone project with 12 credits and for the 4-year honours degree students have to complete a project with 12 credits. Those honours students who are not doing capstone project shall do three courses at the level 400 or above or three vocational training courses or internships for 12 credits.

a) 20% syllabus of each course will be prepared by the teacher as 'Teacher Specific Content' and will be evaluated under CCA.

b) In case of MDC, SEC, VAC courses coming under 3rd & 4th semester, college should make necessary arrangements to give adequate preference to courses designed by language departments. MDC in the 3rd semester can be Kerala Specific Content.

12. Academic Levels of Pathway Courses

Semester	Difficulty level	Nature of Course
1&2	100-199	Foundation level or introductory courses
3&4	200-299	Intermediate level courses
5&6	300-399	Higher level courses
7&8	400-499	Advanced/Capstone level courses

13. Signature Courses

a) With a prior recommendation of BoS and the approval of academic council, each faculty member can design and offer at least one signature course in every semester, which may be offered as DSE/SEC/VAC.

b) College may publish a list of their signature courses in DSE/ SEC/ VAC offered by their faculty members with a prior recommendation of BoS and the approval of Academic Council.

c) College may empanel distinguished individuals who have excelled in their field of specialization like science and technology, industry, commerce, social research, media, literature, fine arts, civil services etc. as adjunct faculty as per the UGC guidelines with the approval of the University/College. With a prior recommendation of BoS and the approval of academic council, the adjunct faculty can offer SEC/VAC as signature course.

d) Adhoc/ Guest faculty/ Visiting faculty/ Visiting Scholars can also offer DSE/SEC/ VAC as signature courses with a prior recommendation of BoS and the approval of academic council.

e) The faculty concerned may design the particular course and it should be forwarded to the BoS after the approval of department council.

f) The examinations and evaluation of the signature courses designed by the faculty shall be conducted by the faculty themselves and an external expert faculty chosen by the college from a panel of experts submitted by the faculty and recommend by the BoS concerned.

14. Programme Pathways and Curriculum Structure

Students who have joined for any programme under these regulations shall have the option to choose the following pathways for their UG degree and Honours programme.

i. **Degree with single Major**: A student pursuing the FYUG programme in a specific discipline shall be awarded a Major degree if he secures at least 50% of the total credits in the specific discipline required for the award of the Degree in that Discipline.
Example: Physics Major/Economics Major/Commerce Major

ii. **Degree Major with Minor**: If a student pursuing the FYUG Programme is awarded a Major Degree in a particular discipline, he/she/they are eligible to be awarded a Minor in another discipline of his choice, if he earns a minimum of 32 credits (approximately 25% of credit required for the three-year programme) from 8 pathway courses in that discipline.
Example: Physics Major with Chemistry Minor/ Chemistry Major with English Minor/ Commerce Major with Economics Minor/ English Major with Functional English Minor/Hindi Major with Malayalam Minor etc.

iii. **Major with Multiple Disciplines of Study**: This pathway is recommended for students who wish to develop core competencies in multiple disciplines of study. In this case, the credits for the minor pathway shall be distributed among the constituent disciplines/ subjects. If a student pursuing FYUG Degree Programme is awarded a major Degree in a particular discipline, he/she/they are eligible to get mentioned his core competencies in other disciplines of his choice if he has earned 12 credits from the pathway courses of that discipline.
Example: Physics Major with Minors in Chemistry and Mathematics, Economics Major with Minors in History and English, Commerce Major with Minors in Economics and Statistics.

iv. **Interdisciplinary Major**: For these programme pathways, the credits for the major and minor pathways shall be distributed among the constituent disciplines/subjects to attain core competence in the inter disciplinary programme.
Example: Econometrics Major, Global Studies Major, Biostatistics Major.

v. **Multi-Disciplinary Major**: For multidisciplinary major pathways, the credits for the major and minor pathways will be distributed among the broad disciplines such

as Life Sciences, Physical Sciences, Mathematical and Computer Sciences, Data Analysis, Social Sciences, Humanities, etc.
Example: Life Science, Data Science, Nano Science.

vi. **Degree with Double Major**: A student who secures a minimum of 50% credits from the first major will be awarded a second major in another discipline if he could secure 40% of credit from that discipline for the 3-year/ 4-year UG degree to be awarded a double major degree.
Example: Physics and Chemistry Major, Economics and History Major, Economics and History Major, Commerce and Management Major

Pathway Option1-Degree Major or Major with Multiple Disciplines of Study

Course Components	No. of Courses											
	Seme-ster 1	Seme-ster2	Seme-ster3	Seme-ster4		Seme-ster5#	Seme-ster6#	Total	Remarks	Seme-ster 7	Seme-ster 8	Total
DSCA (4 Credit/ Course)	1(P)	1(P)	3 (2P)	3 (2P)	**Internship of 2 Credits**	5	4	17	7 Out of 17 can be opted as DSE	3	2	22
DSCB&C (4 Credit /Course)	2(P)	2(P)	1(P) (BorC)	1(P) (CorB)				6		3		9
Multidisciplinary Courses (MDC) (3 Credit/ Course)	1(P)	1(P)	1*					3	*Cannot opt from DSC			3
Ability Enhancement Courses (AEC) (3 Credit/ Course)	1 (English) 1 (OL)	1 (English)1 (OL)						4				4
Skill Enhancement Courses (SEC) (3 Credit/ Course)				1*		1**	1**	3	*Cannot opt from DSCA **From DSCA only			3
Value Addition Courses (VAC) (3 Credit/ Course)			1*	1*			1**	3	*Cannot opt from DSCA **From DSCA only			3
Project/ Dissertation 12 credits for Honours with Research & 8 for Honours											**12 (1 DSC /DSE for Honours**	
Total Courses	**6**	**6**	**6**	**6**		**6**	**6**	**36**		**6**	**2+1**	
Total Credits	**21**	**21**	**22**	**22**	**2**	**23**	**22**		**Total Credits 133**	**24**	**20**	**Total Credits 177**
Total Hours per Week	**25**	**25**	**25**	**25**		**25**	**25**		**Exit option available**	**25**	**25**	

Pathway Option 2 – Major with Minor

Course Components	No. of Courses Seme-ster 1	Seme-ster 2	Seme-ster 3	Seme-ster 4	Internship of 2 Credits	Seme-ster 5#	Seme-ster 6#	Total	Remarks	Seme-ster7	Semester8	Total
DSCA (4Credit/ Course)	1(P)	1(P)	3 (2P)	3 (2P)		4	3	15	7 Out of 15 can be opted as DSE	3	2	22
DSCB (4Credit/ Course)	2(P)	2(P)	1(P)	1(P)		1	1	8	1 Out of 8 can be opted as DSE	3		11
Multidisciplinary Courses (MDC)/ (3Credit/ Course)	1(P)	1(P)	1*					3	*Cannot opt from DSC			3
Ability Enhancement Courses (AEC) (3Credit/ Course)	1 (English)1 (OL)	1 (English) 1 (OL)						4				4
Skill Enhancement Courses (SEC) (3Credit/ Course)				1*		1**	1**	3	*Cannot opt from DSCA **From DSCA only			3
Value Addition Courses (VAC) (3 Credit/ Course)			1*	1*			1**	3	*Cannot opt from DSCA **From DSCA only			3
Project/ Dissertation 12 credits for Honours with Research & 8 for Honours											**12 (1DSC/ DSE for Honours**	
Total Courses	**6**	**6**	**6**	**6**		**6**	**6**	**36**		**6**	**2+1**	
Total Credits	**21**	**21**	**22**	**22**	**2**	**23**	**22**		**Total Credits 133**	**24**	**20**	**Total Credits 177**
Total Hours per Week	**25**	**25**	**25**	**25**		**25**	**25**		**Exit option available**	**25**	**25**	

Pathway Option 3 – Double Major

Course Components	No. of Courses											
	Seme-ster 1	**Seme-ster 2**	**Seme-ster 3**	**Seme-ster 4**		**Seme-ster 5#**	**Seme-ster 6#**	**Total**	**Remarks**	**Seme-ster 7**	**Seme-ster 8**	**Total**
DSC A (4 Credit/ Course)	1(P)	1(P)	2(2P)	2(1P)	Internship of 2 Credits	4	3	13	7 Out of 13 can be opted as DSE	3	2	18
DSC B (4 Credit/ Course)	2(P)	2(P)	2(1P)	2(2P)		1	1	10	2 Out of 10 can be opted as DSE	3		13
Multidisciplinary Courses (MDC) (3 Credit/ Course)	1(P)	1(P)	1*					3	*Cannot opt from DSC			3
Ability Enhancement Courses (AEC) (3 Credit/ Course)	1 (English)1 (OL)	1 (English) 1 (OL)						4				4
Skill Enhancement Courses (SEC) (3 Credit/ Course)				1		1	1	3				3
Value addition Courses (VAC) (3 Credit/ Course)			1	1			1	3				3
Project/Dissertation 12 credits for Honours with Research & 8 for Honours											**12 (1 DSC/DSE for Honours**	
Total Courses	**6**	**6**	**6**	**6**		**6**	**6**	**36**		**6**	**2+1**	
Total Credits	**21**	**21**	**22**	**22**	**2**	**23**	**22**		**TotalCredits133**	**24**	**20**	**Total Credits 177**
Total Hours per Week	**25**	**25**	**25**	**25**		**25**	**25**		**Exit option available**	**25**	**25**	

15. Guidelines for Acquiring Credit from Other Institutions/Online/Distance Mode

a) A student shall register to a minimum of 16 credit per semester from the college/ department where he/ she/ they is officially admitted for a particular programme. However, students enrolled for a particular programme in one institution can simultaneously enrol for additional credits from other HEIs within the University or outside the University subject to a maximum of 30 credits per semester including the 16 institutional credits.

b) The College shall publish a list of courses that are open for admission for students from other institutions well in advance before the commencement of each semester.

c) Each BoS shall prepare and publish a list of online courses at different levels before the commencement of each semester offered in various online educational platforms recognized by the academic council of the College, which can be opted by the students for acquiring additional credits.

d) Each BoS shall prepare and publish a list of allied/relevant pathway courses before the commencement of each semester offered by other Board of Studies that can be considered as pathway courses for major/minor for their disciplines at different levels.

e) At the end of each, the semester College will include the credit acquired by the student through online courses in their semester grade cards subject to a maximum of 30 credits.

16 Attendance

i. A student shall be permitted to register for the end-semester evaluation of a specific course to acquire the credits only if he/ she has completed 75% of the prescribed classroom activities in physical, online, or blended modes, including any other activities as specified by the faculty coordinator of that particular course.

ii. A student is eligible for attendance as per the existing university and government orders which includes participation in a meeting, or events organized by the college or the university, a regularly scheduled curricular or extracurricular activity prescribed by the college or the university. Due to unavoidable or other legitimate circumstances such as illness, injury, family emergency, care-related responsibilities, bad or severe weather conditions, academic or career-related interviews, students are eligible for authorized absence. Apart from this, all other eligible leave such as maternity leave, and menstrual leave shall also be treated as authorized absences.

iii. The condonation facility can be availed as per the College norms.

17. Workload

i. The workload of a faculty who offers only lecture courses during an academic year shall be 32 credits.

ii. The workload of a faculty offering both practical courses and theory courses may be between 24-32 credits per academic year.

iii. An academic year shall consist of two semesters.

iv. To protect the existing language workload, college should make necessary arrangements to give adequate preference to those courses designed by language departments coming under MDC, SEC and VAC of 3rd & 4th semester.

v. Programme wise workload calculation will be as per the FYUGP workload ordinance 2024.

vi. The teachers given the administrative responsibilities in the department and college level may give a relaxation in their workload as specified in the UGC regulations 2018.

18. Credit Transfer and Credit Accumulation

i. College will establish a digital storage (DIGILOCKER) of academic credits for the credit accumulation and transfer in line with ABC.

ii. The validity of credits earned shall be for a maximum period of seven (7) years or as specified in the university/UGC regulations.

iii. The students shall be required to earn at least 50% of the credits from the College.

iv. Students shall be required to earn the required number of credits as per any of the pathway structure specified in this regulation for the award of the degree

19. Outcome Based Approach

The curriculum will be designed based on Outcome Based Education (OBE) practices. The Graduate Attributes (GA) and Programme Outcomes (PO) are provided in appendix-1. The OBE based syllabus template is provided in appendix-2.

20. Assessment and Evaluation

i. The assessment shall be a combination of Continuous Comprehensive Assessment (CCA) and an End Semester Evaluation (ESE).

ii. 30% weightage shall be given for CCA. The remaining 70% weight shall be for the ESE.

iii. Teacher Specific Content will be evaluated under CCA.

iv. CCA will have two subcomponents: Formative Assessment (FA) and Summative Assessment (SA). Each of these components will have equal weightage and must be conducted by the course faculty/course coordinator offering the course.

v. FA refers to a wide variety of methods that teachers use to conduct in-process evaluations of student comprehension, learning needs, and academic progress during a lesson, unit, module or course. FA is to encourage students to build on their strengths rather than fixate or dwell on their deficits. FA can help to clarify and calibrate learning expectations of students. FA will help students become more aware of their learning needs, strengths, and interests so they can take greater responsibility for their educational growth. FA will be the prerogative of the course faculty/course coordinator based on specific requirement of the student.

vi. Suggested methods of FA are as follows: (any one or in combination could be followed as decided by the course faculty/course coordinator)

a. Practical assignment
b. Observation of practical skills
c. Viva voce
d. Quiz
e. Interview
f. Oral presentations
g. Computerized adaptive testing
h. In-class discussions
i. Group tutorial work
j. Reflection writing assignments
k. Home assignments
l. Self and peer Assessments
m. Any other method as may be required for specific course/student by the Course faculty/course coordinator

vii. Summative Assessments (SA) are used to evaluate student learning, skill acquisition, and academic achievement at the conclusion of a defined instructional period- typically at the end of a project, unit, module, course or semester. SA may be class tests, assignments, or project, used to determine whether students have learned what they were expected to learn. It will be based on evidence, collected using single or multiple ways of assessment. The systematically collected evidence should be kept in record by course faculty/course coordinator and the marks should be displayed on the college notice board/ other official digital platforms of the college before the end semester examinations

viii. The method of SA will be as follows: (any one as decided by the course faculty/course coordinator)

   a. Written test
   b. Open book test
   c. Laboratory report
   d. Problem based assignments
   e. Individual project report
   f. Case study report
   g. Team project report
   h. Literature survey
   i. Standardized test
   j. Any other pedagogic approach specifically designed for a particular course by the course faculty/course coordinator.

ix. A student may repeat SA only if there are any compulsive reasons due to which the student could not attend the assessment

x. The prerogative of arranging a CCA lies with the course faculty/course coordinator with the approval of SACA-UGP Academic Committee based on justified reasons

xi. The course faculty/ course coordinator shall be responsible for evaluating all the components of CCA. However, the university may involve any other person (External or Internal) for evaluation of any or all the components as decided by the Vice-Chancellor/Pro-Vice Chancellor from time to time in case any grievances are raised.

xii. Written tests shall be precisely designed using a variety of tools and processes (e.g., constructed responses, open-ended items, multiple-choice), and the students should be informed about the evaluation modalities before the commencement of the course.

xiii. The course faculty may provide options for students to improve their performance through continuous assessment mechanism.

xiv. There shall be theory and practical examinations at the end of each semester.

xv. Regarding evaluation, one credit may be evaluated for 25 marks in a semester; thus, a 4-credit course will be evaluated for 100 marks; and 2-credit courses for 50 marks. However, for tabulation purpose course with 1-credit will be evaluated for 50 marks and will be converted to 25 marks

xvi. Odd semester examinations will be conducted by the institution and will be evaluated at the institution level. However, even semester examinations will be conducted and evaluated by internal and external faculty.

xvii. Individual Learning Plans (ILPs) and/ or specific assessment arrangements may be put in place for differently abled students. Suitable evaluation strategies including technology assisted examinations/alternate examination strategies will be designed and implemented for differently abled students.

xviii. Distribution of CCA & ESE will be as given below

Credit	CCA	ESE
4	30	70
3	25	50
2	15	35

21. Practical Examination

i. The end semester practical examination will be conducted and evaluated by the institution.

ii. There shall be a CCA of practical courses conducted by the course faculty course coordinator.

iii. The scheme of evaluation of practical courses will be as given below:

Components for the Evaluation of Practical Courses	Weightage
CCA of practical/practicum.	30%
ESE conducted under the supervision of internal examiner	70%

iv. Those who have completed the CCA alone will be permitted to appear for the ESE.

v. For grievance redressal purposes, the university shall have the right to call for all the records of CCA.

vi. Duration of Examination
Questions shall be set as per the defined Outcome. The question setter shall ensure that there will be Time and Mode (T & M) flexibility for all External Examinations. BoS can recommend the T&M from the following list.

Mode	**Time (in Hours)**	
	Minimum	**Maximum**
Written Examination	1	2
Multiple Choice	1	1.5
Open Book	1	2
Any Other Mode	1	2

22. Evaluation of Project/Dissertation

The evaluation of project work shall be CCA with 30% and ESE 70%. The scheme of evaluation of the Project is given below

Components of Evaluation of Internship	**Weightage**	**Marks for Internship 2 Credits / 50Marks**
CCA	30%	15
ESE	70%	35

The department council may decide any mode for the completion of the Internship. If in case evaluation is not specified in any of the selected internship programme, institution can adopt a proper evaluation method as per the weightage specified in the table above.

23. Letter Grades and Grade Points

A Mark system is followed for evaluating each question. For each course in the semester, letter grades and grade points are introduced in a 10-point indirect grading system as per the guidelines given below,

i. The Semester Grade Point Average (SGPA) is computed from the grades as a measure of the student's performance in a given semester. The SGPA is based on the grades of the current term, while the Cumulative Grade Point Average (CGPA) is based on the grades in all courses taken after joining the programme of study.

ii. Based on the marks obtained, the weighted grade point will be mentioned in the student's grade cards.

Letter Grade	Grade Point	Percentage of Marks (Both Internal & External Marks put together)	Class
O (Outstanding)	10	95% and above	First Class with Distinction
A+ (Excellent)	9	Above 85% and below 95%	
A (Very good)	8	Above 75% and below 85%	
B+ (Good)	7	Above 65% and below 75%	First Class
B (Above average)	6	Above 55% and below 65%	
C (Average)	5	Above 45% and below 55%	Second Class
P(Pass)	4	Above 35% and below 45% Aggregate (external and internal put together) with a minimum of 30% in external	Third Class
F(Fail)	0	Below an aggregate of 35% or Below 30% in external evaluation	Fail
Ab (Absent)	0		Fail

iii. When students take audit courses, they may be given pass (P) or fail (F) grade without any credits

24. Computation of SGPA and CGPA

The following method is recommended to compute the Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA):

i. The SGPA is the ratio of the sum of the product of the number of credits with the grade points scored by a student in all the courses taken by a student and the sum of the number of credits of all the courses undertaken by a student in the semester, i.e.

$$SGPA(S_i) = \frac{\sum(C_i \times G_i)}{\sum C_i}$$

Where S_i is the SGPA in the ith semester, C_i is the number of credits of the ith course and G_i is the grade point scored by the student in the ith course.

$$\text{SGPA} = \frac{\text{Sum of the credit points of all the courses in a semesters}}{\text{Total Credits in that semester}}$$

Illustration–Computation of SGPA

Semester	Course	Credit	Letter Grade	Grade point	Credit Point (Credit Grade)
I	DSC A	4	A	8	4x8=32
I	DSC B	4	B+	7	4x7=28
I	DSC C	4	B	6	4x6=24
I	MDC	3	B	6	3x6=18
I	AEC 1	3	O	10	3x10=30
I	AEC 2	3	C	5	3x5=15
	Total	21			147
			SGPA		147/21=7

ii. The CGPA is also calculated in the same manner considering all the courses undertaken by a student over all the semesters of a programme i.e.

$$\textbf{CGPA} = \frac{\sum(C_i \times S_i)}{\sum C_i}$$

Where S_i is the SGPA in the ith semester, C_i is the total number of credits in the ith semester.

$$CGPA = \frac{Sum\ of\ the\ credits\ of\ all\ the\ courses\ in\ six/eight\ semesters}{Total\ Credits\ in\ Six(133)/Eight(177)\ semesters}$$

iii. The SGPA and CGPA shall be rounded off to 2 decimal points and reported in the transcripts.

25. Committees to be Constituted for the Implementation and Monitoring of SACA-UGP

i. There shall be a college level SACA-UGP Academic Co-ordinator/Nodal Officer, academic committee and SACA-UGP department committee in each department.

ii. The tenure of the college level committees will be 4 years.

SACA-UGP Academic Committee

i. The Principal (Chairman)

ii. Academic Co-ordinator/Nodal Officer (Convenor)

iii. All the Heads of Departments in the college

iv. Four teachers of the college representing different discipline nominated by the college council by rotation

v. Not less than four experts/academicians from outside the college representing areas such as Industry, Commerce, Education, Sciences etc., to be nominated by the college council preferably from the alumni of the college

vi. Three nominees of the affiliating University (not less than the designation of associate professor in a college/university department)

Functions of SACA-UGP Academic Committee

i. Scrutinize, approve, and recommend to the University all the proposals submitted by the department committee with regard to the SACA-UGP such as, academic pathway, allowed syllabi enrichment/updation, details of elective courses, Online courses, blended teaching, courses offering to the students of other HEIs, panel of examiners, summative and formative evaluation tools proposed by the concerned course faculty, new courses and syllabus proposed by the faculty members as signature courses etc. The Academic Committee can differ on any proposal, and it shall have the right to return the matter for reconsideration to the concerned Department committee or reject it, after giving sufficient reasons to do so.

ii. Scrutiny of all documents related to Teacher Specific Content.

iii. Recommend to the College Governing Body for starting innovative programmes using the flexibility and holistic nature of the SACA-UGP curriculum framework

SACA-UGP Department Committee

i) Head of the Department concerned (Chairman)

ii) The entire faculties of the Department

iii) Two subject experts from outside the college to be nominated by the MGU-UGP Academic Committee

iv) One representative from industry/ corporate sector/ allied area relating to placement

v) One meritorious alumnus of the department to be nominated by the department council

vi) The department council of the S A C A -UGP, may with the approval of the principal of the college, co-opt:

(a) Experts from outside the college whenever special courses of studies are to be formulated.

(b) Other faculty members of the same Faculty within the college

Functions of S A C A -UGP Department Committee

i) Prepare teacher specific content of syllabi for various courses keeping in view the objectives of the SACA-UGP and submit the same for the approval of the academic committee.

ii) Scrutinize the signature course content and its evaluation techniques.

iii) Suggest methodologies for innovative teaching and evaluation techniques.

iv) Suggest panel of examiners to the academic committee.

v) Coordinate research, teaching, extension and other academic activities in the department/college.

26. Proposed Options for Higher Studies for the Students of SACA-UGP

The following higher studies options at the level of post-graduation/research was described by UGC in the national higher education qualification framework;

i) The two-year master programme will continue (with an option of having the second year devoted entirely to research) for those who have completed a 3-year UG programme under the SACA-UGP regulations.

ii) For students who have completed a 4-year honours degree could complete their master programme within one year by acquiring the required credits as per the Post Graduate curriculum framework requirement.

iii) For enrolling in a PhD programme the candidate should have acquired a master degree or a 4-year honours degree with research.

28. Power to Remove Difficulties

If any difficulty arises in giving effect to the provisions of these Regulations, the Principal may by order make such provisions not inconsistent with the Act, Statutes, Ordinances or other Regulations, which appears to him to be necessary or expedient for removing the difficulty. Every order made under this rule shall be subject to ratification by the Governing body.

29. Modifications to the Regulations

Not with standing anything contained in these Regulations, any amendments or modifications issued or notified by the University Grants Commission or the State Government, from time to time, shall be deemed to have been incorporated into these Regulations and shall constitute an integral part thereof.

Appendix-1

Graduate Attributes (GA) of St. Albert's College (Autonomous)

The fundamental premise underlying the learning outcomes-based approach to curriculum planning and development is that, higher education qualifications are awarded on the basis of demonstrated achievement of outcomes (expressed in terms of knowledge, understanding, skills, attitudes and values) and academic standards expected. The expected learning outcomes are used as reference points that would help formulate graduate attributes, qualification descriptors, programme outcomes and course outcomes which in turn will help in curriculum planning and development, and in the design, delivery and review of academic programmes. The graduate attributes of St. Albert's College (Autonomous) are:

GA1: Critical thinking and Analytical reasoning

Capability to analyse and evaluate evidence, arguments, claims, beliefs on the basis of empirical evidence; identify relevant assumptions or implications; formulate coherent arguments; critically evaluate practices, policies and theories to develop knowledge and understanding; critical sensibility to lived experiences, with self-awareness and reflexivity of both self and society.

GA2: Scientific reasoning and Problem solving

Ability to analyse, interpret and draw conclusions from quantitative/qualitative data; and critically evaluate ideas, evidence and experiences from an open-minded and reasoned perspective; capacity to extrapolate from what one has learned and apply their competencies to solve different kinds of non-familiar problems, rather than replicate curriculum content knowledge; and apply one's learning to real life situations.

GA3: Multidisciplinary / interdisciplinary / trans disciplinary Approach

Acquire interdisciplinary / multidisciplinary / transdisciplinary knowledge base as a consequence of the learning they engage with their programme of study; develop a collaborative – multidisciplinary / interdisciplinary / transdisciplinary-approach to formulate constructive arguments and rational analysis for achieving common goals and objectives.

GA4: Intra and Interpersonal skills

Ability to work effectively and respectfully with diverse teams; facilitate cooperative or coordinated effort on the part of a group, and act together as a group or a team in the interests of a common cause and work efficiently as a member of a team; lead the team to guide people to the right destination, in a smooth and efficient way.

GA5: Digital literacy

Capability to use ICT in a variety of learning situations, demonstrate ability to access, evaluate, and use a variety of relevant information sources; and use appropriate software for analysis of data.

GA6: Global citizenship

Possess knowledge of the values and beliefs of multiple cultures and a global perspective; and capability to effectively engage in a multicultural society and interact respectfully with diverse groups.

GA7: Social Competency

Ability to contemplate on the impact of research findings on conventional practices, and a clear understanding of responsibility towards societal needs, and reaching the targets for attaining inclusive and sustainable development.

GA8: Equity, Inclusiveness and Sustainability

Appreciate equity, inclusiveness and sustainability and diversity; acquire ethical and moral reasoning and values of unity, secularism and national integration to enable to act as dignified citizens; able to understand and appreciate diversity (caste, ethnicity, gender and marginalization), managing diversity and use of an inclusive approach to the extent possible.

GA9: Lifelong Learning

Ability to acquire knowledge and skills, including learning how to gain knowledge, that are necessary for participating in learning activities throughout life, through self-paced and self-directed learning aimed at personal development, meeting economic, social and cultural objectives, and adapting to changing trades and demands of workplace through knowledge / skill development/ reskilling.

Programme Outcomes (PO)

PO1: Critical thinking and Analytical reasoning

Capability to analyse and evaluate evidence, arguments, claims, beliefs on the basis of empirical evidence; identify relevant assumptions or implications; formulate coherent arguments; critically evaluate practices, policies and theories to develop knowledge and understanding; critical sensibility to lived experiences, with self-awareness and reflexivity of both the self and the society.

PO2: Scientific reasoning and Problem solving

Ability to analyse, interpret and draw conclusions from quantitative/qualitative data; and critically evaluate ideas, evidence and experiences from an open-minded and reasoned perspective; capacity to extrapolate from what one has learned and apply their competencies to solve different kinds of non-familiar problems, rather than replicate curriculum content knowledge; and apply one's learning to real life situations.

PO3: Multi-disciplinary/interdisciplinary/transdisciplinary Approach

Acquire interdisciplinary/multidisciplinary/transdisciplinary knowledge base, as a result of the learning they engage within their programme of study; develop a collaborative-multidisciplinary/interdisciplinary/transdisciplinary-approach to formulate constructive arguments and rational analysis for achieving common goals and objectives.

PO4: Communication Skills

Ability to express thoughts and ideas effectively in writing and in speech; communicate with others using appropriate media; confidently share one's views and express herself/himself; demonstrate the ability to listen carefully, read and write analytically, and present complex information in a clear and concise manner to different groups.

PO5: Leadership Skills

Ability to work effectively and lead respectfully with diverse teams; setting direction, formulating an inspiring vision, building a team that can help achieve the vision, motivating and inspiring team members to engage with that vision, and using management skills to guide people to the right destination, in a smooth and efficient way.

PO6: Social Consciousness and Responsibility

Ability to contemplate on the impact of research findings on conventional practices, and a clear understanding of responsibility towards societal needs and reaching the targets for attaining inclusive and sustainable development.

PO7: Equity, Inclusiveness and Sustainability

Appreciate equity, inclusiveness and sustainability and diversity; acquire ethical and moral reasoning and values of unity, secularism and national integration to enable to act as dignified citizens; able to understand and appreciate diversity (caste, ethnicity, gender and marginalization), managing diversity and use of an inclusive approach to the extent possible.

PO8: Moral and Ethical Reasoning

Ability to embrace moral/ethical values in conducting one's life, formulate a position/argument about an ethical issue from multiple perspectives, and use ethical practices in all work. Capable of demonstrating the ability to identify ethical issues related to one's work, avoid unethical behaviour.

PO9: Networking and Collaboration

Acquire skills to be able to collaborate and network with educational institutions, research organisations and industrial units in India and abroad.

PO10: Lifelong Learning

Ability to acquire knowledge and skills, including "learning how to learn", that are necessary for participating in learning activities throughout life, through self-paced and self-directed learning aimed at personal development, meeting economic, social and cultural objectives, and adapting to changing trades and demands of workplace through knowledge/skill development/reskilling.

SYLLABUS INDEX

Name of the Major: **Mathematics**

Semester 1

Course Code	Title of the Course	Type of the Course	Credit	Hours/ Week	Hour Distribution /week			
					L	T	P	O
24SACMAT1DA101 *(Major)* 24SACMAT1DB101 *(Minor B)* 24SACMAT1DC101 *(Minor C)*	Ground Roots of Mathematics	Discipline Specific Component - DSC A	4	5	3	0	1	0
24SACMAT1MD101	Mathematics for Competitive Examinations	Foundation Component - MDC	3	4	2	0	1	0

L — Lecture, T — Tutorial, P — Practical/Practicum , O — Others

Semester 2

Course Code	Title of the Course	Type of the Course	Credit	Hours/ Week	Hour Distribution /week			
					L	T	P	O
24SACMAT2DA101 *(Major)* 24SACMAT2DB101 *(Minor B)* 24SACMAT2DC101 *(Minor C)*	A Gateway to Mathematics	Discipline Specific Component - DSC A	4	5	3	0	1	0
24SACMAT2MD101	Applicable Mathematics	Foundation Component - MDC	3	4	2	0	1	0

L — Lecture, T — Tutorial, P — Practical/Practicum , O — Others

Semester 3

Course Code	Title of the Course	Type of the Course	Credit	Hours/ Week	Hour Distribution /week			
					L	T	P	O
24SACMAT3DA201	Perspectives of Mathematics	Discipline Specific Component – DSC A	4	5	3	0	1	0
24SACMAT3DA202	Building Blocks for Higher Mathematics	Discipline Specific Component - DSC A	4	5	3	0	1	0
24SACMAT3DE201	Numerical Methods	Discipline Specific Elective - DSE	4	4	4	0	0	0
24SACMAT3DB201	Essential Mathematics for Science (Physics, Chemistry, Geology, Statistics)	Discipline Specific Component - DSC B	4	5	3	0	1	0
24SACMAT3DB202 24SACMAT3DC202	Mathematics For Business and Economics	Discipline Specific Component – DSC B	4	5	3	0	1	0
24SACMAT3DB203 24SACMAT3DC203	Essential Mathematics for Computing (CS)	Discipline Specific Component - DSC B	4	5	3	0	1	0
24SACMAT3DB204 24SACMAT3DC204	Mathematics for Management (BBA)	Discipline Specific Component - DSC B	4	5	3	0	1	0
24SACMAT3MD201	Mathematics of Nature and Art	Foundation Component - MDC	3	3	3	0	0	0

24SACMAT3VA201*	Mastering Problem Solving through Vedic Mathematics	Foundation Component - VAC	3	3	3	0	0	0

L — Lecture, T — Tutorial, P — Practical/Practicum , O — Others

*** Can be opted by students who have not taken Mathematics as Major**

Semester 4

Course Code	Title of the Course	Type of the Course	Credit	Hours/ Week	Hour Distribution /week			
					L	T	P	O
24SACMAT4DA201	Matrix Algebra and Number Theory	Discipline Specific Component - DSC A	4	5	3	0	1	0
24SACMAT4DA202	Fundamentals of Analysis	Discipline Specific Component - DSC A	4	5	3	0	1	0
24SACMAT4DE201	Operations Research	Discipline Specific Elective - DSE	4	4	4	0	0	0
24SACMAT4DB201 24SACMAT4DC201	Essential Mathematics for Science (Physics, Chemistry, Geology, Statistics)	Discipline Specific Component - DSC B	4	5	3	0	1	0
24SACMAT4DB202 24SACMAT4DC202	Mathematics For Business and Economics	Discipline Specific Component - DSC B	4	5	3	0	1	0
24SACMAT4DB203 24SACMAT4DC203	Essential Mathematics for Computing (CS)	Discipline Specific Component - DSC B	4	5	3	0	1	0

24SACMAT4DB204 24SACMAT4DC204	**Mathematics for Management (BBA)**	**Discipline Specific Component - DSC B**	**4**	**5**	**3**	**0**	**1**	**0**
24SACMAT4VA201*	**Business Mathematics**	**Foundation Component - VAC**	**3**	**3**	**3**	**0**	**0**	**0**
24SACMAT4SE201*	**Document Preparation using LaTeX**	**Foundation Component - SEC**	**3**	**3**	**3**	**0**	**0**	**0**
	Intership	**INT**	**2**					

L — Lecture, T — Tutorial, P — Practical/ Practicum , O — Others

*** Can be opted by students who have not taken Mathematics as Major**

Semester 5

Course Code	**Title of the Course**	**Type of the Course**	**Credit**	**Hours /Week**	**Hour Distribution /week**			
					L	**T**	**P**	**O**
24SACMAT5DA301	**A First Course in Complex Analysis**	**Discipline Specific Component - DSC A**	**4**	**5**	**3**	**0**	**1**	**0**
24SACMAT5DA302	**Limits and Convergence**	**Discipline Specific Component - DSC A**	**4**	**4**	**4**	**0**	**0**	**0**
24SACMAT5DA303	**Fundamentals of Groups and Rings**	**Discipline Specific Component - DSC A**	**4**	**5**	**3**	**0**	**1**	**0**
24SACMAT5DE301	**Differential Equations and Applications**	**Discipline Specific Elective - DSE**	**4**	**4**	**4**	**0**	**0**	**0**
24SACMAT5DE302	**Mathematical Musings Beyond Classroom**	**Discipline Specific Elective - DSE**	**4**	**4**	**4**	**0**	**0**	**0**
24SACMAT5DE303*	**Discrete and Fuzzy**	**Discipline Specific**	**4**	**4**	**4**	**0**	**0**	**0**

	Mathematics	Elective - DSE						
24SACMAT5SE301**	Introduction to Python programming and document preparation using LaTeX	Foundation Component - SEC	3	3	1	0	1	0

L — Lecture, T — Tutorial, P — Practical/Practicum , O — Others

***Signature course by Department of Mathematics, St. Albert's College (Autonomous), Ernakulam**

****Signature course by Department of Mathematics, St. Albert's College (Autonomous), Ernakulam, Can be opted only by students who have taken Mathematics as Major**

Semester 6

Course Code	Title of the Course	Type of the Course	Credit	Hours/ Week	Hour Distribution /week			
					L	T	P	O
24SACMAT6DA301	Mathematical Analysis	Discipline Specific Component - DSC A	4	5	3	0	1	0
24SACMAT6DA302	Fundamentals of Linear Algebra	Discipline Specific Component - DSC A	4	5	3	0	1	0
24SACMAT6DE301	Application of Calculus and Linear Algebra in Finance	Discipline Specific Component - DSE	4	5	3	0	1	0
24SACMAT6DE302	Combinatorics	Discipline Specific Elective - DSE	4	4	4	0	0	0

24SACMAT6DE303	**Fundamentals of Fluid Dynamics**	**Discipline Specific Elective - DSE**	**4**	**4**	**4**	**0**	**0**	**0**
24SACMAT6DE304	**Scilab for Calculations and Visual Presentations**	**Discipline Specific Elective - DSE**	**4**	**4**	**2**	**0**	**1**	**0**
24SACMAT6VA301*	**Mathematical Computation and Visualization with R**	**Foundation Component - VAC**	**3**	**3**	**1**	**0**	**1**	**0**
24SACMAT6SE301*	**Computations and Graphics using SageMath**	**Foundation Component - SEC**	**3**	**3**	**1**	**0**	**1**	**0**
24SACMAT6SE302**	**Number Theory for Programmers**	**Foundation Component - SEC**	**3**	**3**	**1**	**0**	**1**	**0**

L — Lecture, T — Tutorial, P — Practical/Practicum , O — Others

***Can be opted only by students who have taken Mathematics as Major**

****Signature course by Department of Mathematics, St. Albert's College (Autonomous), Ernakulam, Can be opted only by students who have taken Mathematics as Major**

Semester 7

Course Code	**Title of the Course**	**Type of the Course**	**Credit**	**Hours/ Week**	**Hour Distribution / week**			
					L	**T**	**P**	**O**
24SACMAT7CC401	**Advanced Linear Algebra**	**Discipline Capstone Component (Advanced) - DCC**	**4**	**5**	**3**	**0**	**1**	**0**
24SACMAT7CC402	**Theory of Complex Functions**	**Discipline Capstone Component**	**4**	**4**	**4**	**0**	**0**	**0**

		(Advanced) - DCC						
24SACMAT7CC403	Introduction to Metric Spaces	Discipline Capstone Component (Advanced) - DCC	4	4	4	0	0	0
24SACMAT7CE401	Advanced Theory of Groups and Rings	Discipline Capstone Component (Advanced) - DCE	4	4	4	0	0	0
24SACMAT7CE402	Real Analysis	Discipline Capstone Component (Advanced) - DCE	4	4	4	0	0	0
24SACMAT7CE403	Graph Theory	Discipline Capstone Component (Advanced) - DCE	4	4	4	0	0	0

L — Lecture, T — Tutorial, P — Practical/Practicum , O — Others

Semester 8

Course Code	Title of the Course	Type of the Course	Credit	Hours/ Week	Hour Distribution /week			
					L	T	P	O
24SACMAT8CC401	Functional Analysis	Discipline Capstone Component (Advanced) – DCC	4	5	3	0	1	0
24SACMAT8CC402	Measure Theory and	Discipline Capstone Component	4	5	3	0	1	0

	Integration	**(Advanced) – DCC**						
24SACMAT8CE401	**Basic Topology**	**Discipline Capstone Component (Advanced) – DCE**	**4**	**5**	**3**	**0**	**1**	**0**
24SACMAT8CE402	**Field Theory**	**Discipline Capstone Component (Advanced) – DCE**	**4**	**5**	**3**	**0**	**1**	**0**
24SACMAT8CE403	**Optimization Techniques**	**Discipline Capstone Component (Advanced) – DCE**	**4**	**5**	**3**	**0**	**1**	**0**
24SACMAT8PR403	**Project (Research/ Honours)**		**12/8**					

L — Lecture, T — Tutorial, P — Practical/Practicum , O — Others

SEMESTER I

Semester 1

Course Code	Title of the Course	Type of the Course	Credit	Hours/ Week	Hour Distribution /week			
					L	T	P	O
24SACMAT1DA101 *(Major)* 24SACMAT1DB101 *(Minor B)* 24SACMAT1DC101 *(Minor C)*	Ground Roots of Mathematics	Discipline Specific Component - DSC A	4	5	3	0	1	0
24SACMAT1MD101	Mathematics for Competitive Examinations	Foundation Component - MDC	3	4	2	0	1	0

L — Lecture, T — Tutorial, P — Practical/Practicum , O — Others

Department of Mathematics St. Albert's College (Autonomous) Ernakulam

Programme	**B Sc Mathematics**
Course Name	**Ground Roots of Mathematics**
Type of Course	Discipline Specific Component - DSC A
Course Code	**24SACMAT1DA101** ***(Major)/*** **24SACMAT1DB101** ***(Minor B)/*** **24SACMAT1DC101** ***(Minor C)***
Course Level	**100**
Course Summary	This course provides a solid foundation in both mathematical logic and the principles of calculus. Beginning with "Basic Logic", students explore propositional logic, propositional equivalence, predicates, and quantifiers. The course then transitions to "Functions", covering the basics of functions and their graphs, combining functions through shifting and scaling, and introducing inverse functions. The core of the course is dedicated to "Derivatives", where students are introduced to techniques of differentiation without formal proof, higher derivatives, product and quotient rules, derivatives of trigonometric functions using formulas, the chain rule, and implicit differentiation. The focus is on practical applications, preparing students for real-world problem-solving. The course concludes with an exploration of the "Applications of Derivatives", emphasizing the analysis of functions. Topics include determining intervals of increase, decrease, and concavity, identifying relative extrema with geometric implications of multiplicity, applying L'Hôpital's Rule, and addressing indeterminate forms.

<table>
<tr><td>Semester</td><td>1</td><td colspan="3">Credits</td><td>4</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Others</td></tr>
<tr><td>3</td><td>0</td><td>1</td><td>0</td><td>5</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="6">Sets, Set operations and Limits</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand the language of Mathematics and communicate in a proper way.	U	1, 2, 3, 4, 10
2	Understand the geometry of basic functions and their properties.	U	1, 2, 3, 10
3	Analyse the conditions for a function to have an inverse.	An	1, 2, 3
4	Understand and apply the process of differentiation.	A	1, 2, 3, 10
5	Characterize increasing/decreasing functions using their derivatives.	U	1, 2, 3, 10
6	Apply L'Hôpital's rule to evaluate indeterminate forms.	A	1, 2
7	Experience graphing tools in doing and enjoying Mathematics	S	1, 2, 3, 4, 9,10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	1.1	Propositional Logic	2	1
	1.2	Propositional Equivalence	2	1

	1.3	Predicates and Quantifiers	2	1
		Problems (Practicum)	9	1
		Text 2: Chapter 1- Sections: 1.1, 1.3, 1.4		
2	2.1	Set, Set operations, Set identities (Review)	4	1
	2.2	Functions and their graphs (excluding representing functions numerically)	4	2
	2.3	Combining Functions: Shifting and scaling Graphs	4	2,7
	2.4	Inverse Functions	4	3
		Problems (Practicum)	4	1, 2, 3, 7
		Text 3: Chapter 1 - Sections: 1.1, 1.2, Chapter 7 - Section: 7.1 (Inverse functions only)		
3	3.1	Introduction to Techniques of Differentiation (without proof)	3	4
	3.2	Higher derivatives, The product and quotient rules	3	4
	3.3	Derivatives of trigonometric functions (Using formulas only)	3	4
	3 .4	Chain Rule	3	4
	3.5	Implicit Differentiation	3	4
		Problems (Practicum)	5	4
		Text 1: Chapter 2 - Sections: 2.3 to 2.7		
4	4.1	Analysis of Functions I: Increase, decrease and concavity	4	5, 7
	4.2	Analysis of Functions II: Relative extrema	4	5, 7

	4.3	L'Hôpital's Rule	4	6
	4.4	Indeterminate forms	4	6
		Problems (Practicum)	4	5, 6, 7
	Text 1: Chapter 3 - Sections: 3.1, 3.2 (Geometric implications of multiplicity, Analysis of polynomials excluded), Chapter 6 - Section:6.5			
5	**Teacher Specific Contents** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**			

Practicum
● Practicum is designed to provide supervised practical application of theoretical knowledge and skills. ● Its purpose is to encourage creativity and develop Problem solving skills. ● The practicum component is to be done in the classroom under the strict guidance of the teachers. ● A minimum of 30 problems is to be solved, and a handwritten copy of the solutions should be kept in the department.

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)**		
	Lectures, Tutorials and Activity Oriented		
Assessment Types	**MODE OF ASSESSMENT**		
	A	**Continuous Comprehensive Assessment (CCA) [30 marks]**	
		Components	**Mark Distribution**
		Module Test- I	**5** Marks
		Module Test- II	**5** Marks
		Module Test- III	**5** Marks
		Module Test- IV	**5** Marks

		Assignment/Seminar	**5** Marks
		Quiz/Viva voce	**5** Marks
	B	**End Semester Evaluation (ESE)**	

Question Pattern
[Maximum Time 2 Hours, Maximum Marks 70]

Module	Part A **2 Marks**	Part B **6 Marks**	Part C **10 Marks**	Total
I	2	2	1	**5**
II	2	2	2	**6**
III	2	2	1	**5**
IV	2	2	2	**6**
Total no of questions	**8**	**8**	**6**	**22**
Number of questions to be answered	**5**	**5**	**3**	**13**
Total Marks	10	30	30	70

TEXTBOOKS:

1. Anton, Howard, Irl Bivens, Stephen Davis. Calculus. 10th ed. John Wiley & Sons, Inc., 2012.
2. Rosen, Kenneth H. Discrete Mathematics and Its Applications (7th ed.). McGraw Hill Publishing Co. New Delhi, 2013.
3. Thomas, George B., Jr., and Maurice D. Weir. Thomas' Calculus. 12th ed. Pearson, 2009.

SUGGESTED READINGS

1. Hofstadter, Douglas R. Gödel, Escher, Bach: An Eternal Golden Braid. Expanded ed. Basic Books, 2007.
2. Copi, Irving M., Carl Cohen. Introduction to Logic. 5th ed. Routledge, 2018.
3. Stewart, James. Calculus: Early Transcendentals. 10th ed. Cengage Learning, 2023.
4. Thompson, Silvanus P. Calculus Made Easy. 5th ed. Dover Publications, 2014.
5. Thomas, George B., Jr., and Maurice D. Weir. Thomas' Calculus. 15th ed. Pearson, 2023.

ADVANCED READINGS:

1. Hurley, Patrick J. A Concise Introduction to Logic. 11th ed. Wadsworth Publishing, 2018.
2. Copi, Irving M., Carl Cohen. Symbolic Logic. 13th ed. W.W. Norton & Company, 2019.
3. Davis, Philip J. Advanced Calculus. 7th ed. Wiley-Interscience, 2002.
4. Tu, Loring W. Introduction to Manifolds. 3rd ed. Springer, 2012.

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- Determine the output of a combinatorial circuit constructed using basic logic gates. Also Build a digital circuit produces the required output. (Eg: Build a digital circuit that produces the output $(p \vee \neg r) \wedge (\neg p \vee (q \vee \neg r))$ with input bits p, q and .
- Determine whether a given function is injective or surjective using horizontal line test.
- Using a graphing calculator, visualize the effect of stretching and scaling (horizontal &vertica2l) of functions.
- Using a graphing calculator, plot the inverse of graphs and understand the geometric relationship between a graph and its inverse.
- Match the graphs of functions with the graphs of their derivatives. (Eg: Question 23 of section 2.2 in text 3).
- Use a graphing utility to make rough estimates of the locations of all horizontal tangent lines (Eg: Question 49 & 50 of section 2.3 in text 3).
- Use a graphing utility to make rough estimates of the intervals on which $f'(x) > 0$ (Eg: Questions 63 & 64 of section 2.3 in text 3).
- Use the implicit plotting capability of a CAS to graph a curve. (Eg: Question 45 of section 2.7 in text 3), Suggested software: Desmos, GeoGebra etc.

Department of Mathematics
St. Albert’s College (Autonomous)
Ernakulam

<table>
<tr><td>Programme</td><td colspan="6">B Sc Mathematics</td></tr>
<tr><td>Course Name</td><td colspan="6">Mathematics for Competitive Examinations</td></tr>
<tr><td>Type of Course</td><td colspan="6">Foundation Component - MDC</td></tr>
<tr><td>Course Code</td><td colspan="6">24SACMAT1MD101</td></tr>
<tr><td>Course Level</td><td colspan="6">100</td></tr>
<tr><td>Course Summary</td><td colspan="6">This competitive exam-focused mathematics course covers crucial topics like number systems, logical reasoning, data analysis, and mathematical measurements. This course explores concepts such as HCF, LCM, fractions, ratio, percentage, and time-related problem-solving, providing comprehensive preparation for various competitive examinations.</td></tr>
<tr><td>Semester</td><td>1</td><td colspan="3">Credits</td><td>3</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Others</td></tr>
<tr><td>2</td><td>0</td><td>1</td><td>0</td><td>4</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="6">NIL</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No:	Expected Course Outcome	Learning Domains	PO No:
	Upon the successful completion of the course, the student will be able to		

1	Develop a solid understanding of various types of numbers. Master techniques for calculating HCF and LCM and gain proficiency in simplifications, squares and square roots.	K, U, E	1, 2, 10
2	Acquire logical reasoning skills by exploring concepts such as ratio, proportion, percentage, and solving problems related to profit, loss and age and apply these principles to real world scenarios.	K, U, E	1,2, 3, 4, 10
3	Learn the essentials of data analysis, including concepts of simple interest, compound interest and solving calendar problems. Develop analytical skills to interpret and utilize data effectively.	K, U, A	1, 2, 3, 10
4	Gain expertise in mathematical measurements through topics like time and work, time and distance, and stocks and shares. Apply mathematical concepts to solve practical problems in these areas.	K, A, E	1, 2, 3, 10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course Description	CO No:	Hours
1		**Number System and Numerical Techniques**		**18**
	1.1	Type of Numbers	1	
	1.2	HCF and LCM of Numbers	1	
	1.3	Decimal Fractions, Simplification	1	
	1.4	Square Roots and Cube Roots	1	
		Problems (Practicum)	1	
	Text 1: Relevant Portions			
2		**Logical Reasoning & Data Analysis**		**24**
	2.1	Ratio and Proportion	2	

	2.2	Percentage	**2**	
	2.3	Profit and Loss	**2**	
	2.4	Problems on Ages	**2**	
	2.5	Simple Interest & Compound Interest	**3**	
	2.6	Calendar	**3**	
		Problems (Practicum)	**2, 3**	
	Text 1: Relevant Portions			
3		**Mathematical Measurements**		**18**
	3.1	Time and Work	4	
	3.2	Time and Distance	4	
	3.3	Stocks and Shares	4	
		Problems (Practicum)	4	
	Text 1: Relevant Portions			
4	**Teacher Specific Contents** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**			

Practicum

- Practicum is designed to provide supervised practical application of theoretical knowledge and skills.
- Its purpose is to encourage creativity and develop Problem solving skills.
- The practicum component is to be done in the classroom under the strict guidance of the teachers.
- A minimum of 30 problems is to be solved, and a handwritten copy of the solutions should be kept in the department.

<table>
<tr><td rowspan="2">Teaching and Learning Approach</td><td colspan="3">Classroom Procedure (Mode of transaction)</td></tr>
<tr><td colspan="3">Lecture and Tutorial</td></tr>
<tr><td rowspan="16">Assessment Types</td><td colspan="3">MODE OF ASSESSMENT</td></tr>
<tr><td>A</td><td colspan="2">Continuous Comprehensive Assessment (CCA) [25 marks]</td></tr>
<tr><td rowspan="6"></td><td>Components</td><td>Mark Distribution</td></tr>
<tr><td>Module Test- I</td><td>5 Marks</td></tr>
<tr><td>Module Test- II</td><td>5 Marks</td></tr>
<tr><td>Module Test- III</td><td>5 Marks</td></tr>
<tr><td>Assignment/Seminar</td><td>5 Marks</td></tr>
<tr><td>Quiz/Viva voce</td><td>5 Marks</td></tr>
<tr><td>B</td><td colspan="2">End Semester Evaluation (Written)</td></tr>
<tr><td rowspan="7"></td><td colspan="2">Question Pattern
[Maximum Time 75 Minutes, Maximum Marks 50]</td></tr>
<tr><td>Module</td><td>Number of Questions</td></tr>
<tr><td>I</td><td>8</td></tr>
<tr><td>II</td><td>14</td></tr>
<tr><td>III</td><td>8</td></tr>
<tr><td colspan="2">Answer any 25 questions out of 30 Multiple Choice Questions. Each question carries 2 marks.</td></tr>
</table>

TEXT BOOK:

1. Aggarwal, R.S. *Quantitative Aptitude*, Sultan Chand and company Ltd, New Delhi, 2017.

SUGGESTED READINGS:

1. Abhijit Guha, *Quantitative Aptitude for Competitive Examinations*, McGraw Hill Education 2011.
2. Tyra M., *Magical Book on Quicker Maths*., BSC Publishing Company, 2018.

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- Discuss different number systems, such as decimal, binary, octal, and hexadecimal, and their conversions.
- Show how number theory concepts apply in various real-life scenarios, like cryptography or data encoding.
- Provide examples where LCM and HCF are used, such as in simplifying fractions, adding and subtracting fractions, or solving equations.
- Incorporate problems where knowledge of roots is essential, such as in Geometry, Physics, or Engineering.
- Provide examples where ratios and proportions are used in real-life situations, such as in finance, cooking, or map scales.
- Provide examples of profit and loss situations in business, trading, and investment scenarios.
- Discuss problem-solving strategies for analyzing profit and loss situations and determining the best course of action.
- Provide examples of interest calculations in banking, investments, loans, and savings accounts.
- Show the difference between simple interest and compound interest and how they affect the total amount over time.
- Provide examples of time and work problems in production scenarios, team projects, or construction projects.

SEMESTER II

Semester 2

Course Code	Title of the Course	Type of the Course	Credit	Hours/ Week	Hour Distribution /week			
					L	T	P	O
24SACMAT2DA101 ***(Major)*** **24SACMAT2DB101** ***(Minor B)*** **24SACMAT2DC101** ***(Minor C)***	**A Gateway to Mathematics**	**Discipline Specific Component - DSC A**	**4**	**5**	**3**	**0**	**1**	**0**
24SACMAT2MD101	**Applicable Mathematics**	**Foundation Component - MDC**	**3**	**4**	**2**	**0**	**1**	**0**

L — Lecture, T — Tutorial, P — Practical/Practicum , O — Others

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<table>
<tr><td>Programme</td><td colspan="6">B. Sc. Mathematics</td></tr>
<tr><td>Course Name</td><td colspan="6">A Gateway to Mathematics</td></tr>
<tr><td>Type of Course</td><td colspan="6">Discipline Specific Component (DSC A)</td></tr>
<tr><td>Course Code</td><td colspan="6">24SACMAT2DA101 (Major)/ 24SACMAT2DB101 (Minor B)/ 24SACMAT2DC101 (Minor C)</td></tr>
<tr><td>Course Level</td><td colspan="6">100</td></tr>
<tr><td>Course Summary</td><td colspan="6">This course is designed to provide students with a deeper understanding of calculus and linear algebra concepts. The course begins with "Partial Differentiation", covering partial derivatives, the chain rule, and the analysis of extreme values and saddle points. It then progresses into "Integral Calculus," focusing on definite integrals, double integrals, integration methods, and the fundamental theorem of calculus.
The course further explores "Matrices", where students delve into linear systems, coefficient matrices, augmented matrices, and matrix operations such as Gauss elimination and back substitution. Elementary row operations, row-equivalent systems, and the various cases of systems in Gauss elimination are covered, leading to the understanding of row echelon form and its implications.
The final segment of the course introduces "Graph Theory," covering foundational definitions and examples. Topics include connectedness, adjacency, subgraphs, matrix representations, null graphs, complete graphs, cyclic graphs, path graphs, wheels, regular graphs, bipartite graphs, and the complement of a simple Graph</td></tr>
<tr><td>Semester</td><td>2</td><td colspan="3">Credits</td><td>4</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Others</td></tr>
<tr><td>3</td><td>0</td><td>1</td><td>0</td><td>5</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="6">Differentiation, Integration and Matrices</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
	Upon the successful completion of the course, the student will be able to		
1	Understand the concept of partial derivatives and experience its applications	U	1, 2, 3
2	Compute definite integrals of single-variable functions, double integrals and understanding their geometric interpretation.	A	1, 2, 3
3	Apply matrices to solve systems of linear equations using methods of Gaussian elimination and matrix inversion.	A	1, 2, 3, 9, 10
4	Create an insight into the basics of graph theory	C	1, 2, 3, 9, 10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1		**Partial Differentiation**	**20**	
	1.1	Partial derivatives	6	1
	1.2	The Chain rule	5	1
	1.3	Extreme values and saddle points	5	1
		Problems (Practical)	4	1
	Text 3: Chapter 14 - Sections: 14.3, 14.4, 14.7			
2		**Integral Calculus: Definite integrals and double integrals**	**20**	
	2.1	Integrals and Integration methods (Review)	4	2

	2.2	The Definite Integral	4	2
	2.3	The Fundamental Theorem of Calculus (Proof of theorems excluded)	4	2
	2.4	Double Integrals over rectangular regions	4	2
		Problems (Practicum)	4	2
	Text 1: Chapter 7 - Section: 7.1; Chapter 4 - Sections: 4.5 (Discontinuities and integrability excluded), 4.6 (dummy variables, The mean value theorem for integrals and integrating rates of changes excluded); Chapter 14 - Section 14.1			
		Matrices	20	
3	3.1	Linear System, Coefficient Matrix, Augmented Matrix	2	3
	3.2	Gauss Elimination and Back Substitution	4	3
	3.3	Elementary Row Operations, Row-Equivalent Systems	4	3
	3 .4	Gauss Elimination: The three Cases of systems	4	3
	3.5	Row Echelon Form and Information from It	4	3
		Problems (Practicum)	2	3
	Text 2: Chapter 7 - Section: 7.3			
4		**Graph Theory**	**15**	
	4.1	Definitions and examples	2	4

	4.2	Connectedness, Adjacency	2	4
	4.3	Subgraphs	2	4
	4.4	Matrix Representations	2	4
	4.5	Null graphs, Complete graphs, cyclic graphs, path graphs and wheels	2	4
	4.6	Regular graphs, Bipartite graphs, Complement of a simple graph	2	4
		Problems (Practicum)	3	4
	Text 4: Chapter 2, Sections: 2 (Isomorphism excluded), 3 (Cubes, Platonic graphs and three puzzles are excluded)			
5	**Teacher Specific Contents** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**			

Practicum
• Practicum is designed to provide supervised practical application of theoretical knowledge and skills. • Its purpose is to encourage creativity and develop Problem solving skills. • The practicum component is to be done in the classroom under the strict guidance of the teachers. • A minimum of 30 problems is to be solved, and a handwritten copy of the solutions should be kept in the department.

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)**
	Lecture, Tutorial and Activity oriented
	MODE OF ASSESSMENT

<table>
<tr><td rowspan="20">Assessment Types</td><td>A</td><td colspan="5">Continuous Comprehensive Assessment (CCA) [30 marks]</td></tr>
<tr><td rowspan="7"></td><td colspan="3">Components</td><td colspan="2">Mark Distribution</td></tr>
<tr><td colspan="3">Module Test- I</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test- II</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test- III</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test- IV</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Assignment/Seminar</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Quiz/Viva voce</td><td colspan="2">5 Marks</td></tr>
<tr><td>B</td><td colspan="5">End Semester Evaluation (ESE)</td></tr>
<tr><td rowspan="11"></td><td colspan="5">Question Pattern
[Maximum Time 2 Hours, Maximum Marks 70]</td></tr>
<tr><td rowspan="2">Module</td><td>Part A</td><td>Part B</td><td>Part C</td><td rowspan="2">Total</td></tr>
<tr><td>1 Mark (MCQ)</td><td>5 Marks</td><td>10 Marks</td></tr>
<tr><td>I</td><td>5</td><td>2</td><td>1</td><td>8</td></tr>
<tr><td>II</td><td>5</td><td>2</td><td>1</td><td>8</td></tr>
<tr><td>III</td><td>5</td><td>2</td><td>1</td><td>8</td></tr>
<tr><td>IV</td><td>5</td><td>2</td><td>1</td><td>8</td></tr>
<tr><td>Total no of questions</td><td>20</td><td>8</td><td>4</td><td>32</td></tr>
<tr><td>Number of questions to be answered</td><td>20</td><td>6</td><td>2</td><td>28</td></tr>
<tr><td>Total Marks</td><td>20</td><td>30</td><td>20</td><td>70</td></tr>
</table>

TEXTBOOKS:

1. Anton, Howard, Irl Bivens, Stephen Davis. *Calculus*. 10th ed. John Wiley & Sons, Inc., 2012.
2. Kreyszig, Erwin**.** *Advanced Engineering Mathematics***.** 9th ed. Wiley International, 2011.
3. Thomas, George B., Jr., and Maurice D. Weir. *Thomas' Calculus***.** 12th ed. Pearson, 2009.
4. Wilson, Robin J. *Introduction to Graph Theory***.** 4th ed. Addison Wesley Longman Limited, Edinburgh Gate, Harlow, Essex CM20 2JE, England, 1996.

SUGGESTED READINGS:

1. Chartrand, Gary, and Ping Zhang. *A First Course in Graph Theory*. 2nd ed. Pearson, 2013.
2. Spivak, Michael. *Calculus and Applications*. 11th ed. Pearson, 2023.
3. Stewart, James. *Calculus: Early Transcendentals*. 10th ed. Cengage Learning, 2023.
4. Thompson, Silvanus P. *Calculus Made Easy*. 5th ed. Dover Publications, 2014.
5. Thomas, George B., Jr., and Maurice D. Weir. *Thomas' Calculus*. 15th ed. Pearson, 2023.

ADVANCED READINGS:

1. Axler, Sheldon. *Linear Algebra Done Right*. 3rd ed. Springer, 2015.
2. Evans, Lawrence C. *Partial Differential Equations: An Introduction*. 2nd ed. American Mathematical Society, 2010.
3. Diestel, Reinhard. *Graph Theory*. 5th ed. Springer, 2017.
4. Fichtenholz, Grisha M. *Integration of Functions of Several variables*. 2nd ed. American Mathematical Society, 2010.
5. Strang, Gilbert. *Introduction to Linear Algebra*. 5th ed. Wellesley-Cambridge Press, 2016.
6. West, Douglas B. *Introduction to Graph Theory*. 6th ed. Pearson, 2017.

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- Demonstrate how to visualize tangent planes to surfaces at a specific point using partial derivatives.
- Check how to obtain absolute maximum using partial derivatives.
- Use Microsoft excel or spreadsheet to performs basic matrix operations.
- Find the integrals using integration by parts (Problem Solving).
- Integrate rational functions by partial fractions (Problem Solving).
- Finding areas using definite integrals.
- Find the adjacency matrix of some familiar graphs.
- Find the incidence matrix of some familiar graphs.

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Programme	**B. Sc. Mathematics**					
Course Name	**Applicable Mathematics**					
Type of Course	**Foundation Component - MDC**					
Course Code	**24SACMAT2MD101**					
Course Level	**100**					
Course Summary	Through this course, students are able to investigate the fundamental principles of quantitative techniques, delving into matrices, their algebraic operations, and specialized types. Navigate the world of polynomials, focusing on quadratic and cubic equations and learning their solutions and factorization. Discover the power of permutations and combinations through factorial notation, with practical applications. Finally, grasp the dynamics of variable rates of change by knowing basic functions and differentiation principles. This course provides students with the necessary mathematical tools for real-world problem-solving and analytical thinking.					
Semester	**2**	Credits			**3**	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		2	0	1	0	**4**
Pre-requisites, if any	Nil					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
	Upon the successful completion of the course, the student will be able to		
1	Understand and apply matrix algebra	U, A	1, 2, 3, 10
2	Apply quadratic and cubic polynomial techniques, factorization, and solution of quadratic equations to solve problems.	K, U, A	1,2, 4, 10
3	Utilize factorial notation, permutations,	U, A	1, 2, 7,

	combinations, and their applications to solve combinatorial problems.		10
4	Apply differentiation principles, standard rules, and elementary functions to interpret and solve problems involving variable rates encountered in competitive exams.	K, U, A	2, 10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course Description	Hrs	CO No.
1		**Matrices & Polynomials**	**24**	
	1.1	Matrices, Different types of matrices associated with a matrix	4	1
	1.2	Some special types of matrices	3	1
	1.3	Algebra of matrices	3	1
	1.4	Quadratic and cubic polynomials	3	2
	1.5	Solution of quadratic polynomials	3	2
	1.6	Factorisation of quadratic polynomials	3	2
		Problems (Practicum)	5	1, 2
	Text 1: Chapter 1– Sections: 1.4 to 1.6; Chapter 2 - Sections: 2.3 to 2.7 Text 2: Relevant Portions of chapter 10 (Elementary Algebra)			
2		**Permutation and Combination**	**18**	
	2.1	Factorial notation	5	3
	2.2	Permutations & its applications	4	3

	2.3	Combinations & its applications.	4	3
		Problems (Practicum)	5	3
	Text 2: Chapter 14 (Permutation & Combination)			
3		**Differentiation**	**18**	
	3.1	Introduction to techniques of differentiation	4	4
	3.2	The product and quotient rules	3	4
	3.3	Derivatives of trigonometric functions (using formulas only)	3	4
	3.4	The chain rule	3	4
		Problems (Practicum)	5	4
	Text 3: Chapter 2 - Sections 2.3 to 2.6 (without proof of rules/ theorems)			
4	**Teacher Specific Contents** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**			

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<tr><td colspan="2">Module Test- I</td><td>5 Marks</td></tr>
<tr><td colspan="2">Module Test- II</td><td>5 Marks</td></tr>
<tr><td colspan="2">Module Test- III</td><td>5 Marks</td></tr>
<tr><td colspan="2">Assignment/Seminar</td><td>5 Marks</td></tr>
<tr><td colspan="2">Quiz/Viva voce</td><td>5 Marks</td></tr>
<tr><td>B</td><td colspan="3">End Semester Evaluation (Written)</td></tr>
<tr><td rowspan="6"></td><td colspan="3">Question Pattern
[Maximum Time 75 Minutes, Maximum Marks 50]</td></tr>
<tr><td>Module</td><td colspan="2">Number of Questions</td></tr>
<tr><td>I</td><td colspan="2">14</td></tr>
<tr><td>II</td><td colspan="2">8</td></tr>
<tr><td>III</td><td colspan="2">8</td></tr>
<tr><td colspan="3">Answer any 25 questions out of 30 Multiple Choice Questions. Each question carries 2 marks.</td></tr>
</table>

TEXT BOOKS:

1. Shanti Narayan, Mittal P. K., *Text book of Matrices*, S. Chand.
2. M. Tyra, *Magical Book on Quicker Maths*., BSC Publishing Company, 2018.
3. Howard Anton, Irl Bivens, Stephens Davis. *Calculus*, 10th ed. John Wiley & Sons, Inc., 2012.

REFERENCES:

1. Aggarwal, R.S. *Quantitative Aptitude*, Sultan Chand and company Ltd, New Delhi, 2017.
2. Thomas, George B., Jr., and Maurice D. Weir, *Thomas' Calculus*, 12th ed. Pearson, 2009.
3. Edward, Joseph. *Differential Calculus for beginners*, Nabu Press, 2011

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- Discuss different aspects of matrix algebra, including determinant calculation, matrix equations, and solving systems of linear equations using matrices.
- Discuss higher degree polynomials and various methods of polynomial factorization, such as synthetic division, long division and factoring by grouping.
- Illustrate how polynomial equations are represented graphically and how to interpret the behaviour of polynomial functions.
- Include real-life application problems involving permutations and combinations, such as probability, arrangements, and selections.
- Illustrate the applications of derivatives in various fields, such as Physics, Economics, Commerce and Engineering.
- Discuss proofs of differentiation rules or theorems in the sections 2.3, 2.4, 2.5, 2.6 of Text 3

SEMESTER III

Semester 3

Course Code	Title of the Course	Type of the Course	Credit	Hours/ Week	Hour Distribution /week			
					L	T	P	O
24SACMAT3DA201	Perspectives of Mathematics	Discipline Specific Component – DSC A	4	5	3	0	1	0
24SACMAT3DA202	Building Blocks for Higher Mathematics	Discipline Specific Component - DSC A	4	5	3	0	1	0
24SACMAT3DE201	Numerical Methods	Discipline Specific Elective - DSE	4	4	4	0	0	0
24SACMAT3DB201	Essential Mathematics for Science (Physics, Chemistry, Geology, Statistics)	Discipline Specific Component - DSC B	4	5	3	0	1	0
24SACMAT3DB202 24SACMAT3DC202	Mathematics For Business and Economics	Discipline Specific Component – DSC B	4	5	3	0	1	0
24SACMAT3DB203 24SACMAT3DC203	Essential Mathematics for Computing (CS)	Discipline Specific Component - DSC B	4	5	3	0	1	0
24SACMAT3DB204 24SACMAT3DC204	Mathematics for Management (BBA)	Discipline Specific Component - DSC B	4	5	3	0	1	0
24SACMAT3MD201	Mathematics of Nature and Art	Foundation Component - MDC	3	3	3	0	0	0

24SACMAT3VA201*	**Mastering Problem Solving through Vedic Mathematics**	**Foundation Component - VAC**	**3**	**3**	**3**	**0**	**0**	**0**

L — Lecture, T — Tutorial, P — Practical/Practicum , O — Others

*** Can be opted by students who have not taken Mathematics as Major**

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<table>
<tr><td>Programme</td><td colspan="6">B. Sc. Mathematics</td></tr>
<tr><td>Course Name</td><td colspan="6">Perspectives of Mathematics</td></tr>
<tr><td>Type of Course</td><td colspan="6">Discipline Specific Component (DSC A)</td></tr>
<tr><td>Course Code</td><td colspan="6">24SACMAT3DA201</td></tr>
<tr><td>Course Level</td><td colspan="6">200</td></tr>
<tr><td>Course Summary</td><td colspan="6">This course provides a comprehensive exploration of three key areas in advanced mathematics: Analytic Geometry, Theory of Equations, and Multivariable Calculus. Students will delve into the parametrization of plane curves, polar coordinates, conic sections, and conics in polar coordinates. The Theory of Equations section covers roots of equations, relationships between roots and coefficients, transformations of equations, characteristics, and positions of roots, as well as essential theorems and Descartes' rule of signs.

The course progresses into the realm of multivariable calculus, introducing double integrals. Students will learn to evaluate double integrals over general regions, compute areas using double integration, and apply double integrals in polar forms. The focus then shifts to triple integrals, exploring rectangular, cylindrical, and spherical coordinates. Substitutions in both double and triple integrals are covered, enhancing students' problem-solving capabilities.

This course aims to equip students with advanced mathematical tools and problem-solving skills, preparing them for further studies in mathematics or related fields.</td></tr>
<tr><td>Semester</td><td>3</td><td colspan="3">Credits</td><td>4</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Others</td></tr>
<tr><td>3</td><td>0</td><td>1</td><td>0</td><td>5</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="6">Cartesian coordinate system, Division of polynomials using synthetic and usual division</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Demonstrate proficiency in parametrizing plane curves and working with polar coordinates.	A	1,2,3,6,9,10
2	Analyse conic sections and conics in polar coordinates.	An	1,2,3,6,9,10
3	Understand the relationship between roots and coefficients in equations.	U	1,2,3,10
4	Apply transformations to equations and analyse special cases.	A	1,2,3,10
5	Utilize double integrals for area computations and problem-solving in polar forms.	A	1,2,3,6, 10
6	Master triple integrals in rectangular, cylindrical, and spherical coordinates.	A	1,2,3,6, 10
7	Apply substitutions effectively in both double and triple integrals.	A	1,2,10
****Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)***			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1		**Analytic Geometry**		
	1.1	Parametrization of Plane curves	3	1
	1.2	Polar Coordinates	4	1
	1.3	Conic sections	4	2
	1.4	Conics in polar coordinates	4	2
		Problems (Practicum)	5	1, 2
	Text 2: Chapter 11 - Sections: 11.1 (Brachistochrone and Tautochrone excluded), 11.3, 11.6 & 11.7			

2		**Theory of Equations**		
	2.1	Roots of Equation and Relation connecting the roots and coefficients of equation	3	3
	2.2	Transformation of Equations and special cases	2	4
	2.3	Character and Position of the roots of an equation	2	4
	2.4	Some general theorems (without proof) and Descartes' rule of signs (without proof)	3	3, 4
		Problems (Practicum)	5	3, 4
	Text 1: Chapter 6 – Sections: 6.1 to 6.4, 6.7 to 6.10			
3		**Double Integrals**		
	3.1	Double integrals over general regions	7	5
	3.2	Area by double integration	6	5
	3.3	Double integrals in Polar Forms	7	5
	Text 2: Chapter 15 - Sections: 15.2 to 15.4			
4		**Triple Integrals**		
	4.1	Triple Integrals in Rectangular Coordinates	4	6
	4.2	Triple Integrals in Cylindrical and Spherical Coordinates	4	6
	4.3	Substitutions in Double Integrals	3	7
	4.4	Substitutions in Triple Integrals	4	7
		Problems (Double and Triple integrals) (Practicum)	5	5, 6, 7

	Text 2: Chapter 15 - Sections: 15.5, 15.7 & 15.8
5	**Teacher Specific Contents** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**

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• Practicum is designed to provide supervised practical application of theoretical knowledge and skills. • Its purpose is to encourage creativity and develop Problem solving skills. • The practicum component is to be done in the classroom under the strict guidance of the teachers. • A minimum of 30 problems is to be solved, and a handwritten copy of the solutions should be kept in the department.

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)**		
	Lecture, Tutorial and Activity oriented		
Assessment Types	**MODE OF ASSESSMENT**		
	A	**Continuous Comprehensive Assessment (CCA) [30 marks]**	
		Components	**Mark Distribution**
		Module Test- I	5 Marks
		Module Test- II	5 Marks
		Module Test- III	5 Marks
		Module Test- IV	5 Marks
		Assignment/Seminar	5 Marks
		Quiz/Viva voce	5 Marks

	B	End Semester Evaluation (ESE)				
		Question Pattern [Maximum Time 2 Hours, Maximum Marks 70]				
		Module	Part A **1 Mark (MCQ)**	Part B **5 Marks**	Part C **10 Marks**	Total
		I	5	2	1	**8**
		II	5	2	1	**8**
		III	5	2	1	**8**
		IV	5	2	1	**8**
		Total no of questions	**20**	**8**	**4**	**32**
		Number of questions to be answered	**20**	**6**	**2**	**28**
		Total Marks	**20**	**30**	**20**	**70**

TEXT BOOKS:

1. Bernard, S., J. M. Child. *Higher Algebra*. AITBS Publishers, India
2. Thomas, George B., Jr., Maurice D. Weir. *Thomas' Calculus*, 12th ed. Pearson, 2009.

SUGGESTED READINGS:

1. Berling, William P. *Journey through Genius: The Great Theorems of Algebra and Their Proofs*. Revised ed. Springer, 2016.
2. Spivak, Michael. *Calculus and Applications*. 11th ed. Pearson, 2023.
3. Stewart, James. *Calculus: Early Transcendentals*. 10th ed. Cengage Learning, 2023.
4. Stewart, James. *Multivariable Calculus*. 9th ed. Cengage Learning, 2023.
5. Thompson, Silvanus P. *Calculus Made Easy*. 5th ed. Dover Publications, 2014.
6. Thomas, George B., Jr., and Maurice D. Weir. *Thomas' Calculus*. 15th ed. Pearson, 2023.

ADVANCED READINGS:

1. Artin, Michael. *Algebra: Structures and Applications*. 5th ed. Springer, 2011.
2. Byron, Frederick W., and Robert W. Fuller. *Advanced Analytic Geometry*. 2nd ed Dover Publications, 1970.
3. Evans, Lawrence C. *Algebraic Number Theory*. 2nd ed. Cambridge University Press, 2019.
4. Davis, Philip J. *Advanced Calculus*. 7th ed. Wiley-Interscience, 2002.

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- Construct a cycloid artwork by tracing the path of a point on a rolling cycle.
- Solve Cubic equations.
- Solve Bi-quadric equation.
- Use double integrals to calculate surface area of three- dimensional object.
- Visualize 3-D surface using any computer software (GeoGebra, Scilab etc).

Department of Mathematics
St. Albert’s College (Autonomous) Ernakulam

Programme	B. Sc. Mathematics			
Course Name	Building Blocks for Higher Mathematics			
Type of Course	Discipline Specific Component (DSC A)			
Course Code	**24SACMAT3DA202**			
Course Level	200			
Course Summary	This course serves as an essential bridge to advanced mathematical concepts, focusing on the development of proof techniques, an in- depth exploration of relations, equivalence relations, partial ordering, vector differentiation, and vector integration. Students will gain proficiency in constructing and understanding mathematical proofs, explore the properties of relations, and delve into the derivatives and integrals of vector functions. The course begins with an "Introduction to Proofs," covering terminologies, theorem statements, and both direct and indirect proof methods. Special attention is given to common mistakes in proofs, enhancing students' ability to critically assess mathematical arguments. The second segment delves into "Relations," examining their properties and methods of representation. Equivalence relations and partially ordered sets are explored, including the construction and interpretation of Hasse Diagrams and Lattices. The latter part of the course transitions into "Vector Calculus," where students will study vector functions, derivatives of vector functions, arc length, unit tangent vectors, curvature, normal vectors of a curve, and directional derivatives. The course concludes with an exploration of vector integration, covering line integrals, vector fields, and their applications, including work, circulation, and flux. Fundamental theorems such as path independence, conservative fields, and potential functions are introduced, with the exclusion of detailed proofs. Green’s theorem in the plane and the divergence theorem are presented, emphasizing their statements and practical problem-solving.			
Semester	3	Credits	4	Total Hours

Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	0	1	0	**5**
Pre-requisites, if any	Vector Algebra					

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
	Upon the successful completion of the course, the student will be able to		
1	Develop proficiency in constructing and understanding mathematical proofs.	A	1,2,4,10
2	Analyse and apply properties of relations and represent them effectively.	An	1,2,9
3	Understand the concepts of equivalence relations and partially ordered sets.	U	1,2,9
4	Explore vector functions, derivatives, arc length, and curvature of curves.	A	1,2,3, 9
5	Master line integrals, vector fields, and their applications.	An	1,2,3,9
6	Apply fundamental theorems in vector calculus to problem-solving.	A	1,2,3,9, 10
7	Strengthen critical thinking skills through practical applications of mathematical concepts	S	1,2,3,9, 10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Sk (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1		**Relations and Proof Techniques**		
	1.1	Terminologies and Understanding How Theorems are Stated	2	1
	1.2	Direct Proofs	2	1, 7
	1.3	Indirect Proofs	2	1, 7
	1.4	Mistakes in Proofs	2	1, 7
	1.5	Relations and their properties	2	2
	1.6	Representation of Relations	2	2, 7
		Problems (Practicum)	3	2,7
		Text 1: Chapter 1 - Section: 1.7; Chapter 9 - Sections: 9.1 & 9.3		
2		**Equivalence relations and Partial ordering**		
	2.1	Equivalence Relations	4	3
	2.2	Partially Ordered Set	4	3
	2.3	Hasse Diagrams	4	3
	2.4	Lattices	4	3
		Problems (Practicum)	4	2, 3, 7
		Text 1: Chapter 9 - Sections: 9.5 & 9.6		

3		**Vector Differentiation**		
	3.1	Vector Algebra (Review), Vector functions, Derivatives of vector functions	4	4
	3.2	Arc length and unit tangent vector	4	4
	3.3	Curvature and normal vectors of a curve	4	4
	3.4	Directional derivatives and Gradient vectors	4	4
		Problems (Practicum)	4	4
		Text 2: Chapter 13 - Sections: 13.1, 13.3, 13.4; Chapter 14 - Section: 14.5		
4		**Vector Integration**		
	4.1	Line integrals	4	5
	4.2	Vector fields and line integrals: work, circulation and flux	3	5
	4.3	Path independence, conservative field and potential function (proofs of theorems excluded)	3	5
	4.4	Green's theorem in plane (statement and problems only)	3	5, 6
	4.5	Curl, Divergence in three dimensions	3	5, 6
		Problems (Practicum)	4	5,6
		Text 2: Chapter 16 - Sections: 16.1 to 16.4,16.7 (Curl only) & 16.8 (Divergence in three dimensions only)		

5		**Teacher Specific Contents** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**		

Practicum
• Practicum is designed to provide supervised practical application of theoretical knowledge and skills. • Its purpose is to encourage creativity and develop Problem solving skills. • The practicum component is to be done in the classroom under the strict guidance of the teachers. • A minimum of 30 problems is to be solved, and a handwritten copy of the solutions should be kept in the department.

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)**		
	Lecture, Tutorial and Activity oriented		
Assessment Types	**MODE OF ASSESSMENT**		
	A	**Continuous Comprehensive Assessment (CCA) [30 marks]**	
		Components	**Mark Distribution**
		Module Test- I	5 Marks
		Module Test- II	5 Marks
		Module Test- III	5 Marks
		Module Test- IV	5 Marks
		Assignment/Seminar	5 Marks
		Quiz/Viva voce	5 Marks

	B	**End Semester Evaluation (ESE)**				
		Question Pattern [Maximum Time 2 Hours, Maximum Marks 70]				
		Module	Part A **1 Mark (MCQ)**	Part B **5 Marks**	Part C **10 Marks**	Total
		I	5	2	1	**8**
		II	5	2	1	**8**
		III	5	2	1	**8**
		IV	5	2	1	**8**
		Total no of questions	**20**	**8**	**4**	**32**
		Number of questions to be answered	**20**	**6**	**2**	**28**
		Total Marks	**20**	**30**	**20**	**70**

TEXT BOOKS:

1. Rosen, Kenneth H. *Discrete Mathematics and Its Applications* (7th ed.). McGraw Hill Publishing Co. New Delhi, 2013.
2. Thomas, George B., Jr., Maurice D. Weir**.** *Thomas' Calculus***.** 12th ed. Pearson, 2009**.**

SUGGESTED READINGS:

1. Griffiths, David J. *Introduction to Electromagnetism*. 4th ed. Cambridge University Press, 2013.
2. Joyce, David D., and George C. Parker. *Vector Calculus and Its Applications*. 4th ed. Jones & Bartlett Publishers, 2022.
3. Schroeder, Glenn N. *Vector Analysis for Computer Graphics*. 3rd ed. A K Peters/CRC Press, 2017.
4. Tenenbaum, Morris T., and Harry Pollard. *Mathematics for the Nonmathematician: An Intuitive Approach.* 8th ed. Dover Publications, 2013.

ADVANCED READINGS:

1. Borceux, Francis. *Universal Algebra*. 2nd ed. Springer, 2003.
2. Farin, Susan E., and Wayne S. Sayle. *Vector Calculus*. 5th ed. Freeman, 2018.
3. Hayes, Martin H. C. *Introduction to Mathematical Proofs*. 2nd ed. Oxford University Press, 2021.

4. Maddox, Randall. *A Transition to Advanced Mathematics*. 8th ed. American Mathematical Society, 2023.

5. Velleman, Daniel J. *How to Prove It: A Structured Approach*. 4th ed. Pearson, 2015.

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- Apply vector integration techniques to model projectile motion.
- Plot vector valued functions using graphing calculators and visualise concepts of gradient and directional derivatives.
- Visualize position, velocity and acceleration of a moving object using sci-lab.
- Compute distance travelled and speed for motion along a space curve.
- Experience other commonly used proof methods like exhaustive prof, proof by cases, existence proof etc.
- Study Stoke's theorem and use it for evaluating circulation of vector functions.
- Discuss oriented surface and non-oriented surface with the help of a Mobius band.

Department of Mathematics
St. Albert's College (Autonomous)
Ernakulam

Programme	**B.Sc. Mathematics**					
Course Name	**Numerical Methods**					
Type of Course	**Discipline Specific Elective – DSE**					
Course Code	**24SACMAT3DE201**					
Course Level	**200**					
Course Summary	Calculation of error and approximation is a necessity in all real life, industrial and scientific computing. The objective of this course is to acquaint students with various numerical methods of finding solution of different type of problems, which arises in different branches of science such as locating roots of equations, finding solution of systems of linear equations and differential equations, interpolation, differentiation, evaluating integration.					
Semester	**3**	Credits			**4**	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4	0	0	0	**4**
Pre-requisites, if any						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
	Upon the successful completion of the course, the student will be able to		
1	Find the consequences of finite precision and the inherent limits of numerical methods	E	1,2
2	Find appropriate numerical methods to solve algebraic and transcendental equations.	E	1,2,3
3	Use numerical methods to find missing values of data.	A	1,2,3,6

4	Apply numerical methods to solve real life problems	C	1,2,3,10
***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)**			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course Description	Hrs	CO No.
1			**15**	
	1.1	Numerical Analysis: Mathematical Preliminaries, Errors and Their Computations.	5	1
	1.2	Introduction, Bisection Method, Method of False Position.	5	2,3
	1.3	Iteration Method, Newton - Raphson Method	5	2,3
	Text 1: Chapter 1 - Sections: 1.2 to 1.3; Chapter 2 – Sections: 2.1 to 2.5.			
2			**15**	
	2.1	Interpolation: Finite Differences, Differences of a polynomial.	5	4
	2.2	Newton's Formulae for Interpolation.	5	3,4
	2.3	Central Difference: Gauss's Central difference formulae.	5	4
	Text 1: Chapter 3 - Sections: 3.3, 3.5, 3.6 & 3.7.1			
3			**15**	
	3.1	Interpolation with Unevenly Spaced Points: Lagrange's Interpolation Formula.	5	3,4
	3.2	Divided Differences and Their Properties.	5	3,4

	3.3	Inverse Interpolation.	5	3,4
	Text 1- Chapter 3 - Sections: 3.9.1, 3.10 & 3.11			
4			**15**	
	4.1	Numerical differentiation and Integration: Numerical differentiation, Errors in Numerical Differentiation.	5	1,3
	4.2	Differentiation Formulae with Function Values.	5	2,4
	4.3	Numerical integration: Trapezoidal Rule, Simpson's 1/3- rule, Simpson's 3/8- rule.	5	4
	Text 1- Chapter 6 - Sections: 6.2.1,6.2.3, 6.4.1 to 6.4.3			
5	**Teacher Specific Contents** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)**		
	Lecture, Teaching, Interactive Instruction, Seminar, Group Assignment, Library Work and Group Discussion		
Assessment Types	**MODE OF ASSESSMENT**		
	A	**Continuous Comprehensive Assessment (CCA) [30 marks]**	
		Components	**Mark Distribution**
		Module Test- I	5 Marks
		Module Test- II	5 Marks
		Module Test- III	5 Marks
		Module Test- IV	5 Marks
		Assignment/Seminar	5 Marks
		Quiz/Viva voce	5 Marks

	B	**End Semester Evaluation (ESE)**				
		Question Pattern [Maximum Time 2 Hours, Maximum Marks 70]				
		Module	Part A **1 Mark (MCQ)**	Part B **5 Marks**	Part C **10 Marks**	Total
		I	5	2	1	**8**
		II	5	2	1	**8**
		III	5	2	1	**8**
		IV	5	2	1	**8**
		Total no of questions	**20**	**8**	**4**	**32**
		Number of questions to be answered	**20**	**6**	**2**	**28**
		Total Marks	**20**	**30**	**20**	**70**

TEXT BOOKS:

1. Sastry, S. S. *Introductory methods of Numerical Analysis,5th edition, PHI Learning Private Limited, 2013.*

REFERENCES:

1. Jain, M. K., Iyengar, S. R. K., & Jain R. K. Numerical Methods for *Scientific and Engineering Computation (6th ed.).* New Age International Publishers. Delhi, 2012.
2. Bradie, Brian. *A Friendly Introduction to Numerical Analysis*. Pearson Education India, 2006.
3. Chapra, Steven C. *Applied Numerical Methods with MATLAB for Engineers and Scientists (4th ed.).* McGraw-Hill Education, 2018.
4. Fausett, Laurene V. *Applied Numerical Analysis Using MATLAB.* Pearson. India, 2009

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- Problem solving using the methods discussed in the module 1, 2, 3 and 4
- Extra reading and practice: Stirling's formula, Bessel's formula, Boole's and Weddle's Rules

Department of Mathematics
St. Albert’s College (Autonomous)
Ernakulam

<table>
<tr><td>Programme</td><td colspan="6">B. Sc. Chemistry, B. Sc. Physics, B. Sc. Geology,
B. Sc. Statistics etc.</td></tr>
<tr><td>Course Name</td><td colspan="6">Essential Mathematics for Science</td></tr>
<tr><td>Type of Course</td><td colspan="6">Discipline Specific Component (DSC B)</td></tr>
<tr><td>Course Code</td><td colspan="6">24SACMAT3DB201 / 24SACMAT3DC201</td></tr>
<tr><td>Course Level</td><td colspan="6">200</td></tr>
<tr><td>Course Summary</td><td colspan="6">This Mathematics minor course complements and enhances the undergraduate programmes on science disciplines such as Physics, Chemistry etc., by enabling the students to understand the concepts of complex numbers and analytic functions, to solve differential equations of different types, to identify different conic sections and its applications in possible areas and to determine unit tangent vector, principal normal vector, and curvature of different curves.</td></tr>
<tr><td>Semester</td><td>3</td><td colspan="3">Credits</td><td>4</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Others</td></tr>
<tr><td>3</td><td>0</td><td>1</td><td>0</td><td>5</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="6">Basic awareness of coordinate systems, vectors, functions, derivatives, and integrals</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
	Upon the successful completion of the course, the student will be able to		
1	Understand the concepts of complex functions and vector calculus	K	1
2	Apply C-R equations to check the analyticity of complex functions	A	2
3	Analyse the nature of differential equation	An	1
4	Solve equations in complex variables and differential equations	A	2

5	Distinguish between cartesian and polar co- ordinates	An	1
6	Identify conic sections from its equations and Visualize curves	E	2
7	Find the curvature and directional derivatives of curves	E	2
8	Develop applications of mathematical concepts in scientific/real life problems	C	3
***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)**			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course Description	Hrs	CO No.
1		**Complex Functions**	**20**	
	1.1	Complex Numbers, Sums and Products, Basic Algebraic Properties, moduli, conjugates, Exponential and Polar Forms, Products and Powers in Exponential form	6	1
	1.2	Functions of Complex Variables, Separation into Real and Imaginary parts, Limits and Continuity	5	1
	1.3	Derivatives, Analytic Function, Cauchy-Riemann Equations, Laplace Equation, Harmonic Function	6	2
		Problems (Practicum)	3	1, 2
		Text 1: Chapter 1 – Sections: 1 to 7; Chapter 2 – Sections: 12,15,16,18 to 22, 24 to 26. Theorems – Statements Only		
2		**Differential Equations**	**18**	
	2.1	Degree, Order, Solution of Differential Equations, Variable Separable method	6	3, 4
	2.2	Exact Differential Equations	5	3, 4
	2.3	Linear Differential Equations, Bernoulli's Equations	5	4

		Problems (Practicum)	2	3, 4
		Text 2: Chapter 1 – Sections: 1.1 to 1.5 Theorems – Statements Only		
3		**Analytic Geometry**	**17**	
	3.1	Polar coordinates	5	5
	3.2	Conic sections	4	6
	3.3	Conic section in polar coordinates	4	6
		Problems (Practicum)	4	5,6
		Text 3: Chapter 11 – sections: 11.3,11.6 & 11.7 Theorems – Statements Only		
4		**Vector Calculus**	**20**	
	4.1	Curves in Space and tangents, Velocity and Acceleration, Arc length in space	6	1, 8
	4.2	Curvature and Normal vectors of a curve	5	1, 7
	4.3	Directional derivatives and gradient vectors	5	1, 7
		Problems (Practicum)	4	1,7,8
		Text 3: Chapter 13 – Sections: 13.1, 13.3, 13.4; Chapter 14 – Section: 14.5. Theorems – Statements Only		
5	**Teacher Specific Contents** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**			

Practicum
• Practicum is designed to provide supervised practical application of theoretical knowledge and skills. • Its purpose is to encourage creativity and develop Problem solving skills. • The practicum component is to be done in the classroom under the strict guidance of the teachers. • A minimum of 30 problems is to be solved, and a handwritten copy of the solutions should be kept in the department.

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)**				
	Direct Instruction, Brainstorming Lecture, Explicit Teaching, Active Co-operative Learning				

Assessment Types	**MODE OF ASSESSMENT**					
	A	**Continuous Comprehensive Assessment (CCA) [30 marks]**				
		Components			**Mark Distribution**	
		Module Test- I			5 Marks	
		Module Test- II			5 Marks	
		Module Test- III			5 Marks	
		Module Test- IV			5 Marks	
		Assignment/Seminar			5 Marks	
		Quiz/Viva voce			5 Marks	
	B	**End Semester Evaluation (ESE)**				
		Question Pattern [Maximum Time 2 Hours, Maximum Marks 70]				
		Module	Part A	Part B	Part C	Total
			1 Mark (MCQ)	**5 Marks**	**10 Marks**	
		I	5	2	1	**8**
		II	5	2	1	**8**
		III	5	2	1	**8**
		IV	5	2	1	**8**

		Total no of questions	**20**	**8**	**4**	**32**
		Number of questions to be answered	**20**	**6**	**2**	**28**
		Total Marks	**20**	**30**	**20**	**70**

TEXT BOOKS:

1. James Ward Brown, Ruel V. Churchill. *Complex Variables and Applications, Eighth Edition*, McGraw Hill, *2009*
2. Simmons, G.F., Krantz, S.G. *Differential Equations*, Tata McGraw Hill-New Delhi, 2007.
3. Thomas, George B Jr. *Thomas' Calculus, Twelfth Edition*, Pearson, 2010

REFERENCES:

1. Grewal, B. S., *Higher Engineering Mathematics, 44th Edition*, Khanna Publishers, 2021.
2. Anton, H., Bivens, Devis. *Calculus, tenth Edition*, Wiley India.
3. Kreyszig,E. *Advanced Engineering Mathematics*, Wiley, India.
4. Siddiqi, A.H., Manchanada, P. *A first course in Differential Equations*, Mc Millan.

SUGGESTED READINGS:

- Proofs of theorems from module 1, 2, 3 & 4
- Solution of equations in Complex variables, Regions in the Complex plane
- Homogeneous Differential equations, Integrating Factors of Differential Equations
- Visualization of curves and conic section, Obtaining Points of farthest and closest approach of Planets/ Satellites
- Integration in vector fields, Finding Work done, Flow, circulation and flux
- Text 1-Chapter 1 (Roots of complex numbers, Regions in complex plane)
- Text 2 – Chapter 1 (Homogeneous Differential Equations, Integrating factors)
- Text 3 – Chapter 16 (Line integrals, Work, Circulation and Flux)

Department of Mathematics St. Albert's College (Autonomous) Ernakulam

<table>
<tr><td>Programme</td><td colspan="6">BA Economics and B Com</td></tr>
<tr><td>Course Name</td><td colspan="6">Mathematics for Business and Economics</td></tr>
<tr><td>Type of Course</td><td colspan="6">Discipline Specific Component (DSC B)</td></tr>
<tr><td>Course Code</td><td colspan="6">24SACMAT3DB202 / 24SACMAT3DC202</td></tr>
<tr><td>Course Level</td><td colspan="6">200</td></tr>
<tr><td>Course Summary</td><td colspan="6">Mathematical methods and theories applicable in economics and business to analyse real life problems are included in the course. First module provides an understanding of the way in which financial calculations are worked out. Second module deals with different methods of solving systems of equations and the many varied applications of such systems to business and economics. Optimization of functions using their derivatives is included in the third module. Linear programming is helpful in business and economics where it is often necessary to optimize a profit or cost function subject to several inequality constraints. The graphic approach for maximization and minimization linear programming problems is also illustrated. Module four deals with the applications of calculus in economics and business.</td></tr>
<tr><td>Semester</td><td>3</td><td colspan="3">Credits</td><td colspan="2">4</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Tutorial</td><td>Practicum</td><td>Others</td><td>Total Hours/week</td></tr>
<tr><td>3</td><td>0</td><td>1</td><td>0</td><td>5</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="6">Graphing functions, Basics of differential and integral Calculus, Multi-variable functions and partial differentiation, Percentage calculation, Basics of logarithmic and exponential functions</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
	Upon the successful completion of the course, the student will be able to		
1	Understand the difference between simple and compound interest	U	1,3
2	Calculate the future value of a principal under annual compounding and under continuous compounding	A	2,3
3	Recognize a geometric progression	K	2
4	Evaluate a geometric series and calculate the total investment obtained from a regular savings plan.	E	2,3,10
5	Use net present values to appraise investment projects and calculate the internal rate of return, the present value of an annuity	A	2,3,10
6	Use discounting to compare investment projects	U, A	1,3
7	Understand functions, classical optimization techniques and marginal concepts in economics	U	1,3
8	Analyse the real-life problems in business and economics and to model it mathematically	A, An, C	2,3,6,10
9	Apply elementary algebra and calculus in economics and business problems and solve it mathematically	A, C	1,2,3
10	Solve linear programming problem using graphical method	C	2
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	CO No.	Hours
1		**Mathematics of Finance**		**15**
	1.1	Compound Interest	1,2	

	1.2	Geometric Series	3,4	
	1.3	Investment Appraisal	5,6	
		Problems (Practicum)	1,2,3,4, 5,6	
	Text 2: Chapter 3 – Sections: 3.2 to 3.4			
2		**Mathematical Economics**		20
	2.1	Introduction to System of Equations	7	
	2.2	Graphical Solutions	7,8	
	2.3	Supply-and-Demand Analysis	8,9	
	2.4	Break-Even Analysis	8,9	
	2.5	Elimination and Substitution Methods	8,9	
	2.6	Income Determination Models	8,9	
	2.7	IS-LM Analysis	8,9	
		Problems (Practicum)	7,8,9	
	Text 1: Chapter 4 – Sections: 4.1 to 4.7			
3		**Optimization Techniques**		**25**

	3.1	Use of Graphs in LPP, Maximization Using Graphs	7,10	
	3.2	The Extreme-Point Theorem, Minimization Using Graphs	7,10	
	3.3	Optimization of Functions, The Successive-Derivative Test	7	
	3.4	Marginal Concepts in Economics	7,8,9	
	3.5	Optimizing Economic Functions for Business	8,9	
	3.6	Relationship Among Total, Marginal, and Average Functions	9	
		Problems (Practicum)	7,8,9,10	
	Text 1: Chapter 7 – Sections: 7.1 to 7.4; Chapter 10 – Sections: 10.6 to 10.10			
4		**Applications of Mathematics in Economics and Business**		**15**
	4.1	Functions of Several Independent Variables	7	
	4.2	Constrained Optimization problems with Lagrange Multipliers	7,8,9	
	4.2	Applications of definite integral in consumers and producers surplus	8,9	
		Problems (Practicum)	7,8,9	
	Text 1: Chapter 12 – Section: 12.11; Chapter 13 – Sections: 13.1 & 13.6			
5	**Teacher Specific Contents** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**			

<table>
<tr><td rowspan="2">Teaching and Learning Approach</td><td colspan="6">Classroom Procedure (Mode of transaction)</td></tr>
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<tr><td>A</td><td colspan="5">Continuous Comprehensive Assessment (CCA) [30 marks]</td></tr>
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<tr><td colspan="3">Module Test- I</td><td colspan="2">5 Marks</td></tr>
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<tr><td>B</td><td colspan="5">End Semester Evaluation (ESE)</td></tr>
<tr><td rowspan="10"></td><td colspan="5">Question Pattern
[Maximum Time 2 Hours, Maximum Marks 70]</td></tr>
<tr><td rowspan="2">Module</td><td>Part A</td><td>Part B</td><td>Part C</td><td rowspan="2">Total</td></tr>
<tr><td>1 Mark (MCQ)</td><td>5 Marks</td><td>10 Marks</td></tr>
<tr><td>I</td><td>5</td><td>2</td><td>1</td><td>8</td></tr>
<tr><td>II</td><td>5</td><td>2</td><td>1</td><td>8</td></tr>
<tr><td>III</td><td>5</td><td>2</td><td>1</td><td>8</td></tr>
<tr><td>IV</td><td>5</td><td>2</td><td>1</td><td>8</td></tr>
<tr><td>Total no of questions</td><td>20</td><td>8</td><td>4</td><td>32</td></tr>
<tr><td>Number of questions to be answered</td><td>20</td><td>6</td><td>2</td><td>28</td></tr>
<tr><td>Total Marks</td><td>20</td><td>30</td><td>20</td><td>70</td></tr>
</table>

TEXT BOOKS:

1. Edward T Dowling, *Mathematical Methods for Business and Economics*, Schaum'sOutline Series, McGraw Hill, 2009.
2. Ian Jacques, *Mathematics for Economics and Business*, 5th Edition, Prentice Hall,2006.

SUGGESTED READINGS:

1. Taro Yamne, *Mathematics for Economists-An elementary survey*, Prentice -Hall, Inc.
2. Robert Brechner, *Contemporary Mathematics for Business and Consumers*, Fifth Edition
3. Das, N. G., Das, J K. *Business Mathematics and Statistics*, Tata McGraw-Hill, 2012.
4. Martin Anthony, Norman Biggs, *Mathematics for economics and finance Methods and Modelling*, Cambridge University Press, 2012.

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- Application mathematics in economics and business using spreadsheets

Department of Mathematics St. Albert's College (Autonomous) Ernakulam

Programme	**B Sc Computer Science/ BCA/ B Sc Cyber forensic**					
Course Name	**Essential Mathematics for Computing (CS)**					
Type of Course	**Discipline Specific Component (DSC B)**					
Course Code	**24SACMAT3DB203 / 24SACMAT3DC203**					
Course Level	**200**					
Course Summary	This course provides a comprehensive introduction to discrete mathematics and algorithms, covering topics such as number theory, cryptography, Boolean algebra, logic gates, relations, tree structures and graph theory. Practical implementation involves coding tree traversal, depth-first search and breadth-first search algorithms using a programming language. Students gain both theoretical insights and hands -on experience applicable across computer science domains.					
Semester	**3**	**Credits**			**4**	
Course Details	**Learning Approach**	Lecture	Tutorial	Practicum	Others	Total Hours/week
		3	0	1	0	**5**
Pre-requisites, if any	Basic understanding of integers and divisibility, basic algebraic operations, set theory and set operations and basic graph theory concepts.					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
	Upon the successful completion of the course, the student will be able to		
1	Understand the fundamental concepts of number theory, including prime numbers and divisibility	U	2
2	Apply congruence in various mathematical scenarios and recognize its applications in Hashing and Cryptography.	A	8
3	Analyze the truth tables and logical operations associated with each type of logic gates.	An	1
4	Understand the relations and it's representations	U	2
5	Apply the basic concepts of trees and tree traversal techniques	A	2
6	Apply knowledge of spanning trees and understand their applications in different domains	A	3
7	Analyze the security implications and practical applications of the RSA cryptosystem	An	8
8	Apply tree traversal algorithm, depth-first search algorithm and breadth-first search algorithm to solve real world problems, using any suitable programming language.	C	9
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	CO No.	Hours
1		**Number theory & Cryptography**		
	1.1	Divisibility and modular arithmetic:- Division, Division algorithm, Modular arithmetic, Congruence and Basic properties of congruence.	1,2	

	1.2	Primes and Greatest common divisor :- Primes, Fundamental theorem of arithmetic (statement and problems only), Greatest common divisors and least common multiples, Euclidean algorithm, g.c.d as linear combination	2	**17**
	1.3	Applications of number theory: a) Solving congruence :- Linear congruence, Chinese remainder theorem and Fermat's theorem (Statement only) b) Application of congruence :-Hashing function	2	
		c) Cryptography :- Caesar cipher, Vignere cipher and Hill cipher		
		Problems (Practicum)	1,2	
	Text 1: Chapter 4 – Sections: 4.1, 4.3 to 4.6 **Text 2: Chapter 10 – Section: 10.1**			
2		**Boolean algebra**		
	2.1	Boolean functions	3	**13**
	2.2	Representing of Boolean functions Sum Of Products (SOP)	3	
	2.3	Logic gates	3	
		Problems (Practicum)	3	
	Text 1: Chapter 11 – Sections: 11.1 to 11.3			
		Relations & Partial orders		

3	3.1	Relations & properties	4	**20**
	3.2	Representing relations	4	
	3.3	Equivalence relation	4	
	3.4	Partial ordering & Hasse Diagrams	4	
		Problems (Practicum)	4	
	Text 1: Chapter 8 – Sections: 8.1, 8.3, 8.5 & 8.6			
4		**Trees**		
	4.1	Introduction to trees:- Trees, Properties of trees, Applications of trees:- Binary search trees, Prefix codes and Huffman coding	5	**25**
	4.2	Tree traversal:- Traversal algorithms, Infix, Prefix and postfix notations	7,8	
	4.3	Spanning trees: - Introduction, Depth-first search algorithm (BFS), Breadth--first search algorithms (DFS)	5	
	4.4	Minimum spanning trees:- Algorithms for minimum spanning trees- Kruskal's algorithm and Prim's algorithm	6	
		Problems (Practicum)	5,6,7,8	
	Text 1: Chapter 10 – Sections: 10.1 to 10.5			

5	**Teacher Specific Contents** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**

Practicum
• Practicum is designed to provide supervised practical application of theoretical knowledge and skills. • Its purpose is to encourage creativity and develop Problem solving skills. • The practicum component is to be done in the classroom under the strict guidance of the teachers. • A minimum of 30 problems is to be solved, and a handwritten copy of the solutions should be kept in the department.

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)**		
	Direct instruction: Lecture Method, Tutorial ,Brainstorming Lectures, Explicit Teaching Interactive instructions: Active Cooperative Learning, Library Work and Group Discussion, Peer Learning, Authentic Learning		
Assessment Types	**MODE OF ASSESSMENT**		
	A	**Continuous Comprehensive Assessment (CCA) [30 marks]**	
		Components	**Mark Distribution**
		Module Test- I	**5** Marks
		Module Test- II	**5** Marks
		Module Test- III	**5** Marks
		Module Test- IV	**5** Marks
		Assignment/Seminar	**5** Marks
		Quiz/Viva voce	**5** Marks

	B	End Semester Evaluation (ESE)				
		Question Pattern [Maximum Time 2 Hours, Maximum Marks 70]				
		Module	Part A **1 Mark (MCQ)**	Part B **5 Marks**	Part C **10 Marks**	Total
		I	5	2	1	**8**
		II	5	2	1	**8**
		III	5	2	1	**8**
		IV	5	2	1	**8**
		Total no of questions	**20**	**8**	**4**	**32**
		Number of questions to be answered	**20**	**6**	**2**	**28**
		Total Marks	**20**	**30**	**20**	**70**

TEXT BOOKS:

1. Kenneth H Rosen, *Discrete Mathematics and its Applications (Eighth Edition),* Tata McGraw- Hill Education (India) private limited, Special Indian Edition 2021.
2. Burton, David M. *Elementary Number theory (Seventh edition),* The McGraw Hill companies, 2009.

SUGGESTED READINGS:

1. Clifford Stien., Robert L Drysdale., Kenneth Bogart. *Discrete Mathematics for computer scientists*; Pearson Education; Dorling Kindersley India Pvt Ltd.
2. Kenneth A Ross., Charles R.B.Wright., *Discrete Mathematics*; Pearson Education; Dorling Kindersley India Pvt Ltd.
3. Richard Johnsonbaugh. *Discrete Mathematics.* Pearson Education; Dorling Kindersley India Pvt Ltd.

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- RSA public key cryptosystem
- Implement tree traversal algorithm, depth-first search algorithm and breadth-first search algorithm using any suitable programming language.
- Text 1-4.6, 10.3, 10.4
- Text 2- Section 10.1

Department of Mathematics
St. Albert's College (Autonomous) Ernakulam

Programme	**BBA**					
Course Name	**Mathematics for Management**					
Type of Course	**Discipline Specific Component (DSC B)**					
Course Code	**24SACMAT3DB204 / 24SACMAT3DC204**					
Course Level	**200**					
Course Summary	The fundamental topics covered in business mathematics are Ratios and Proportion Variation, Indices, Permutation and Combinations Linear Simultaneous Equations Simple and Compound interest including the application of Annuity.					
Semester	**3**	**Credits**			**4**	
Course Details	**Learning Approach**	Lecture	Tutorial	Practicum	Others	Total Hours/ week
		3	0	1	0	**5**
Pre-requisites, if any						

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
	Upon the successful completion of the course, the student will be able to		
1	Grasping the fundamental principles of Permutations and combinations.	U	3

2	Developing problem solving skills involving arrangements, selections and distributions.	S	8
3	Ability to interpret and analyse financial data presented in various formats.	An	2
4	Understanding how matrices are applied in diverse fields like statistics, optimization, and data analysis.	A	7
5	Students should be able to comprehend and represent matrices using mathematical notation, and understand their properties and operations.	R	3
6	Proficiency in solving systems of linear equations using matrices and determinants. This includes the application of matrices in solving real-world problems related to linear systems.	E	6
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	**Units**	**Course Description**	**CO No:**	**Hours**
1		**Algebra**		15
	1.1	Variation	1	
	1.2	Permutations	1	
	1.3	Combinations	1	
		Problems (Practicum)	1	
	Text 1: Chapter 8. **Text 2: Chapter 6 – Section: 6.3**			

2		**Progressions and Commercial Arithmetic**		**20**
	2.1	Percentage	2	
	2.2	Profit and Loss	**2**	
	2.3	Simple interest, Compound interest	**3**	
		Problems (Practicum)	**2,3**	
	Text 1: Chapter 10,11,14 & 15			
3		**Fundamental topics in Geometry and Mathematics**		**15**
	3.1	Rectangular Co-ordinates	**2**	
	3.2	Straight lines-Point slope form,1-point form,2- point form, Intercept form, General equation to other forms.	**2**	
	3.3	Angle between two lines, Condition for parallelism and perpendicular.	**2**	
		Problems (Practicum)	**2**	
	Text 3: Chapter 1 – Sections: 1 to 4, Chapter 2 – Sections: 1,2,3,5,7, 9(9.1,9.2 only)			
4		**Matrix and Measurement**		**25**
	4.1	Concept of a matrix, algebra of matrices	**5**	

	4.2	Determinant of a square matrix- Expansion only.	**5**	
	4.3	solution of a system of linear equations up to three variable using Cramer's Rule	6	
		Problems (Practicum)	5	
	Text 4: Chapter 1,2 & 8			
5	**Teacher Specific Contents** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**			

Practicum
• Practicum is designed to provide supervised practical application of theoretical knowledge and skills. • Its purpose is to encourage creativity and develop Problem solving skills. • The practicum component is to be done in the classroom under the strict guidance of the teachers. • A minimum of 30 problems is to be solved, and a handwritten copy of the solutions should be kept in the department.

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)**		
	Direct Instruction: Brain Storming Lecture, Explicit Teaching, E-learning Interactive Instruction: Active Co-operative Learning, Seminar, Group Assignments, Authentic Learning, Library Work and Group Discussion, Presentation by Individual Student/ Group Representative		
	MODE OF ASSESSMENT		
	A	**Continuous Comprehensive Assessment (CCA) [30 marks]**	
		Components	**Mark Distribution**
		Module Test- I	**5** Marks
		Module Test- II	**5** Marks

<table>
<tr><td rowspan="17">Assessment Types</td><td rowspan="4"></td><td colspan="3">Module Test- III</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test- IV</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Assignment/Seminar</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Quiz/Viva voce</td><td colspan="2">5 Marks</td></tr>
<tr><td>B</td><td colspan="5">End Semester Evaluation (ESE)</td></tr>
<tr><td rowspan="12"></td><td colspan="5">Question Pattern
[Maximum Time 2 Hours, Maximum Marks 70]</td></tr>
<tr><td rowspan="2">Module</td><td>Part A</td><td>Part B</td><td>Part C</td><td rowspan="2">Total</td></tr>
<tr><td>1 Mark (MCQ)</td><td>5 Marks</td><td>10 Marks</td></tr>
<tr><td>I</td><td>5</td><td>2</td><td>1</td><td>8</td></tr>
<tr><td>II</td><td>5</td><td>2</td><td>1</td><td>8</td></tr>
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<tr><td>Total Marks</td><td>20</td><td>30</td><td>20</td><td>70</td></tr>
</table>

TEXT BOOKS:

1. M.Tyra and K.Kundan, Concept of Arithemetic for Competitive exams, BSC Publishing Co.Pvt.Ltd, New Delhi, 2011.
2. Rosen, Kenneth H. *Discrete Mathematics and Its Applications* (7th ed.). McGraw Hill Publishing Co. New Delhi, 2013.
3. T.K. Manicavachagom Pillay; T.Natarajan; Analytical Geometry, S.Viswanathan, Pvt.Ltd,2008.
4. M.L Khanna, Algebra, Jai Prakash Nath and Co. Educational Publishers, Meerut.

SUGGESTED READINGS:

1. Sancheti, D. C., & Kapoor, V. K. (2009). *Business Mathematics*. New Delhi: Sultan Chand and Sons.
2. S. Saha, *Business Mathematics and statistics.* NCBA, 2010.

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- Familiarise the students the concept of Computing present value of annuities.
- Solve linear equations without using Cramer's rule.

Department of Mathematics
St. Albert's College (Autonomous)
Ernakulam

Programme	**B. Sc. Mathematics**
Course Name	**Mathematics of Nature and Art**
Type of Course	**Foundation Component - MDC**
Course Code	**24SACMAT3MD201**
Course Level	**200**
Course Summary	The course explores Fibonacci numbers' diverse applications in nature, arts, science, and the significance of the golden ratio and continued fractions in various contexts. It helps to understand their role in natural phenomena, artistic expressions, mathematical principles, and practical applications across disciplines.

Semester	**3**	Credits			**3**	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	0	0	0	**3**
Pre-requisites, if any	Nil					

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
	Upon the successful completion of the course, the student will be able to		
1	Understand Fibonacci and Lucas numbers, their properties, and applications in natural phenomena and diverse real-world scenarios.	U, A	2, 3
2	Analyze and apply Fibonacci's impact on artistic expressions, scientific realms, and interdisciplinary connections across various fields.	K, U, A	1, 2, 3
3	Comprehend the significance of the golden ratio, its geometric interpretations, and applications in human anatomy, arts and mathematical constructions.	K, U, A	2, 3, 10
4	Understand and apply the concepts of finite and infinite	K, U, A	2, 3

	continued fractions, convergence, recursive definitions, and their implications in solving problems.		
****Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)***			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course Description	Hrs	CO No.
1		**Fibonacci Numbers in Nature, Arts & Science**	**16**	
	1.1	The rabbit problem, Fibonacci numbers, Recursive definition, Lucas numbers, Fibonacci and Lucas primes.	4	1
	1.2	Different types of Fibonacci and Lucas numbers.	3	1
	1.3	Fibonacci numbers in nature: Fibonacci and the earth, Fibonacci and flowers, Fibonacci and trees, Fibonacci and sunflowers, Fibonacci - pinecones, artichokes and pineapples, Fibonacci and bees, Fibonacci and subsets.	3	1
	1.4	Fibonacci and atoms, Fibonacci and reflections. Fibonacci - paraffins and cycloparaffins, Fibonacci and music, Fibonacci and poetry.	3	2
	1.5	Fibonacci and compositions with 1's and 2's, Fibonacci and neurophysiology. (Theorems 3.1, 3.2, 3.3 - statement only)	3	2
	Text 1: Chapters 2 & 3 (Relevant sections only)			
2		**Fibonacci Numbers in Arts and Science**	**15**	
	2.1	The golden ratio, Mean proportional, A geometric interpretation.	5	3
	2.2	Ruler and compass construction, Euler construction. Generation by Newton's method.	5	3

	2.3	The golden ratio revisited: Golden ratio and human body, Mexican Pyramids, Differential equations, Golden ratio and centroids of circles.	5	3
	Text 1: Chapters 20 & 21 (Relevant sections only)			
3		**Continued Fractions**	**14**	
	3.1	Finite continued fractions, Convergents of a continued fraction.	5	4
	3.2	Recursive definition, Infinite continued fraction.	4	4
	3.3	An infinite continued fraction for –, Pell's equation.	5	4
	Text 1: Chapter 27			
4	**Teacher Specific Contents** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)**		
	Lecture and Tutorial		
Assessment Types	**MODE OF ASSESSMENT**		
	A	**Continuous Comprehensive Assessment (CCA) [25 marks]**	
		Components	**Mark Distribution**
		Module Test- I	**5** Marks
		Module Test- II	**5** Marks
		Module Test- III	**5** Marks
		Assignment/Seminar	**5** Marks
		Quiz/Viva voce	**5** Marks

	B	**End Semester Evaluation (ESE)**				
		Question Pattern [Maximum Time 90 Minutes, Maximum Marks 50]				
		Module	Part A	Part B	Part C	Total
			1 Mark (MCQ)	**5 Marks**	**10 Marks**	
		I	7	2	1	**10**
		II	7	2	1	**10**
		III	6	2	0	**8**
		Total no of questions	**20**	**6**	**2**	**28**
		Number of questions to be answered	**20**	**4**	**1**	**11**
		Total Marks	**20**	**20**	**10**	**50**

TEXT BOOKS:

1. Thomas Koshy. *Fibonacci and Lucas numbers with applications*, John Wiley & Sons, Inc, 2001.

REFERENCES:

1. Richard A Dunlap. *The Golden Ratio and Fibonacci Numbers*, World Scientific Publishing Co. Pt. Ltd.
2. Mario Livio. *The Golden Ratio*, Broadway Books, New York.

SUGGESTED READINGS:

- Fibonacci and male bees.
- Fibonacci and sewage treatment.
- Fibonacci and the Balmer series.
- Proofs of Theorems 3.1, 3.2 and 3.3.
- Fibonacci and electrical networks.
- Violin and golden triangle.
- Golden ratio by origami.
- Gattei's discovery of golden ratio.

Department of Mathematics St. Albert's College (Autonomous) Ernakulam

Programme	**B Sc Mathematics**
Course Name	**Mastering Problem Solving through Vedic Mathematics**
Type of Course	**Foundation Component - VAC**
Course Code	**24SACMAT3VA201**
Course Level	**200**
Course Summary	This course provides a comprehensive exploration of Vedic Mathematics, a traditional Indian system known for its speed and efficiency in problem-solving. Through a structured four-unit approach, students will understand the importance of Vedic Mathematics, advanced arithmetic techniques, root calculations, and applications in algebra, empowering them with valuable tools for quick and accurate problem-solving.

Semester	**3**	Credits			**3**	Total Hours/ Week
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	0	0	0	**3**
Pre-requisites, if any	Nil					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
	Upon the successful completion of the course, the student will be able to		
1	Develop a comprehensive understanding of Vedic Mathematics principles, techniques, and their historical context.	U	1,2,3,4,8, 10
2	Attain proficiency in mental calculation techniques for addition, subtraction, multiplication, and division,	S	1,2,4,8,1 0

	fostering quicker and more accurate problem-solving.		
3	Apply Vedic Mathematics to solve a diverse range of mathematical problems, including algebraic expressions and equations, showcasing versatility in problem-solving.	A	1,2,3,4,8, 10
4	Develop advanced problem-solving skills through the systematic application of Vedic Mathematics techniques, enabling students to tackle complex scenarios with confidence.	A, An	1,2,3,4,8, 10
5	Gain confidence and readiness to tackle competitive exams by mastering quantitative aptitude using Vedic Mathematics techniques, ensuring a competitive edge in various examinations.	A, An	1,2,4,5,8, 10
6	Apply Vedic Mathematics skills to real-world scenarios, including ratio and proportions, percentage calculations, profit and loss analysis, and interest calculations.	A	1,2,3,4,8, 10
7	Apply Vedic Mathematics principles to algebraic expressions, including efficient multiplication of polynomials and solving systems of linear equations.	A, An	1,2,3,4,8, 10
8	Empower students with traditional Indian mathematical wisdom, providing them with valuable tools deeply rooted in cultural and historical contexts.	U, I, Ap	1,3,6,7,8, 10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	CO No:	Hours
1		**Foundations of Vedic Mathematics**		12
	1.1	Overview of Vedic Mathematics- History and its importance, Vedic Sutras and sub-sutras	1,8	
	1.2	Addition : Ekadhikena Purvena	1,2	
	1.3	Subtraction: Nikhilam Navatascaramam Dasatah, Digit Separator Method	1,2	

	1.4	Multiplication : Ekanyunena Purvena, Multiplication of numbers having two-digits and three-digits using Urdhva Tiryagbhyam, Multiplication by series of 1's and 9's	1,2	
	1.5	Division : Urdhva – Tiryakgbhyam	1,2,5	
		Text 1: Specified sections from Chapters 1 to 4 & 6		
2		**Advanced Arithmetic Techniques and its Applications**		19
	2.1	Squares: Squares of numbers up to three-digits using Ekadhikena Purvena, Dwanda yoga	1,2,5	
	2.2	Square roots : Duplex Method	1, 2, 5	
	2.3	Cubes: Cubes of two-digit numbers using Nikhilam	1,2,5	
	2.4	Cube roots : Cube Root of a number having less than 7 digits using Beejank	1, 2, 5	
	2.5	Divisibility and simple Osculators	1,2,5	
	2.6	Applications: Ratio and proportions, Percentage, Profit and Loss, Simple interest, Compound Interest	3, 4, 5, 6, 8	
		Text 1: Specified sections from Chapter 7, 8, 10 & 11 **Text 2: Chapter 29** **Text 3: Chapter 18, 20, 23, 24 & 25**		
3		**Algebraic Multiplication and Equation Solving**		14
	3.1	Multiplication in algebra : Multiplication of polynomials of the form ax+by, ax^2+bx+c	1,3,7	

	3.2	Simple Equations: Solving simple equations in one variable	1,3,7	
	3.3	Simultaneous Simple Equations : Solution of system of linear equations in two variables	1,3,7,8	
	Text 1: Specified sections from Chapter 5 **Text 2: Specified sections from Chapters 11, 12, 13 & 15**			
4	**Teacher Specific Contents** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)**					
	Interactive Lectures, Conduct Regular Practical Workshops Focusing on Mental Calculation Techniques and Vedic Mathematics Applications, Provide Hands-on Exercises with Immediate Feedback to Reinforce Learning.					
Assessment Types	**MODE OF ASSESSMENT**					
	A	**Continuous Comprehensive Assessment (CCA) [25 marks]**				
		Components	**Mark Distribution**			
		Module Test- I	**5** Marks			
		Module Test- II	**5** Marks			
		Module Test- III	**5** Marks			
		Assignment/Seminar	**5** Marks			
		Quiz/Viva voce	**5** Marks			
	B	**End Semester Evaluation (ESE)**				
		Question Pattern **[Maximum Time 90 Minutes, Maximum Marks 50]**				
		Module	Part A **1 Mark (MCQ)**	Part B **5 Marks**	Part C **10 Marks**	Total
		I	7	2	1	**10**
		II	7	2	1	**10**

		III	6	2	0	**8**
		Total no of questions	**20**	**6**	**2**	**28**
		Number of questions to be answered	**20**	**4**	**1**	**11**
		Total Marks	**20**	**20**	**10**	**50**

TEXT BOOKS:

1. Thakur, Rajesh Kumar. *The Essentials of Vedic Mathematics,* Rupa Publications India Pvt Ltd, 2013.
2. Bharati Krishna Tirthaji. *Vedic Mathematics*: *Sixteen Simple Mathematical formulae from the Vedas,* Motilal Banarsidass, 1981.
3. Tyra, M. *Magical Book On Quicker Maths*, BSC Publishing Co. Pvt. Ltd, 5th Edition, 2018.

SUGGESTED READINGS:

1. Singhal, Vandana. *Vedic Mathematics for all ages: A Beginner's Guide*, Motilal Banarsidass, 2014.
2. Patankar, U. S., S. M. Patankar. *Elements of Vedic Mathematics*, TTU Press, 2018.

ADVANCED READING:

1. Dattoli, Giuseppe, Marcello Artioli, Silvia Licciardi. *Vedic Mathematics: A Mathematical Tale from the Ancient Veda to Modern Times*, World Scientific Publishing Co Pte Ltd, 2021.

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- Relevant topics can be selected from Textbook 3

SEMESTER IV

Semester 4

Course Code	Title of the Course	Type of the Course	Credit	Hours/ Week	Hour Distribution /week			
					L	T	P	O
24SACMAT4DA201	Matrix Algebra and Number Theory	Discipline Specific Component - DSC A	4	5	3	0	1	0
24SACMAT4DA202	Fundamentals of Analysis	Discipline Specific Component - DSC A	4	5	3	0	1	0
24SACMAT4DE201	Operations Research	Discipline Specific Elective - DSE	4	4	4	0	0	0
24SACMAT4DB201 24SACMAT4DC201	Essential Mathematics for Science (Physics, Chemistry, Geology, Statistics)	Discipline Specific Component - DSC B	4	5	3	0	1	0
24SACMAT4DB202 24SACMAT4DC202	Mathematics For Business and Economics	Discipline Specific Component - DSC B	4	5	3	0	1	0
24SACMAT4DB203 24SACMAT4DC203	Essential Mathematics for Computing (CS)	Discipline Specific Component - DSC B	4	5	3	0	1	0
24SACMAT4DB204 24SACMAT4DC204	Mathematics for Management (BBA)	Discipline Specific Component - DSC B	4	5	3	0	1	0
24SACMAT4VA201*	Business Mathematics	Foundation Component - VAC	3	3	3	0	0	0

24SACMAT4SE201*	**Document Preparation using LaTeX**	**Foundation Component - SEC**	**3**	**3**	**3**	**0**	**0**	**0**	
	Intership	**INT**	**2**						

L — Lecture, T — Tutorial, P — Practical/ Practicum , O — Others

*** Can be opted by students who have not taken Mathematics as Major**

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Programme	**B Sc Mathematics**					
Course Name	**Matrix Algebra and Number Theory**					
Type of Course	**Discipline Specific Component (DSC A)**					
Course Code	**24SACMAT4DA201**					
Course Level	**200**					
Course Summary	This course provides an introduction to the fundamental concepts and techniques of matrix algebra and number theory. The first two modules deal with matrix algebra and solutions of systems of linear equations. Third module starts with basics for theory of numbers which will be followed by the division and Euclidean algorithm. Fourth Module involves some classical theorems by Fermat, Wilson and Euler.					
Semester	4	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	**0**	**1**	**0**	5
Pre-requisites, if any	Basic idea about matrices, integers and primes.					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
	Upon the successful completion of the course, the student will be able to		
1	Demonstrate a thorough understanding of the basic concepts of matrix algebra	U	1,2,3
2	Formulate systems of linear equations into matrices	U	1,2,4

3	Solve systems of linear equations using Gaussian elimination	A	1,2,3
4	Analyze the properties of systems of linear equations and their solutions	An	1,2,3,4
5	Demonstrate understanding of fundamental concepts in number theory, including congruence, divisibility, GCD etc.	U	1,2
6	Analyze Fermat's Little Theorem, understanding its significance and implications	An	1,2,3
7	Comprehend Euler's Phi Function and Euler's Theorem and Wilson's theorem and their applications in determining primality.	U	1,2,3
8	Apply computational software and tools in matrix computations and also concepts of number theory.	A	1,2,3,9
****Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)***			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	CO No.	Hours
1	1.1	Matrix Operations	1	20
	1.2	Properties of matrix operations	1	
	1.3	Different types of matrices	1	
	1.4	Matrix representation of system of linear equations	2	
	1.5	Elementary row transformations and elementary matrices	3	
	1.6	Gaussian Elimination, Row-echelon form, Hermite form	3	
		Problems (Practicum)		

	Text 1: Chapter 1; Chapter 3 [upto Exercise 3.10 -Theorems (Statement only) of all theorems in Chapter 3]			
2	2.1	Linear combination and independence/dependence of rows and columns of matrices	4	15
	2.2	Row equivalent matrices	4	
	2.3	Row rank, column rank and rank of a matrix	4	
	2.4	Normal form and equivalent matrices	4	
	2.5	Consistency of system of linear equations	4	
	2.6	Invertible Matrices	4	
		Problems (Practicum)		
	Text 1: Remaining portions of Chapter 3 and Chapter 4 [Theorems (Statement only) and their applications]			
3	3.1	The Division Algorithm	5	20
	3.2	The Greatest Common Divisor	5	
	3.3	The Euclidean Algorithm	5	
	3.4	The Fundamental Theorem of Arithmetic	5	
	3.5	The Sieve of Erasthosthanese	5	
		Problems (Practicum)		
	Text 2: Chapter 2 – Sections: 2.2 (Statements and applications only), 2.3 [Theorem 2.3 and 2.4(Statements only)], 2.4 [Theorem 2.7 and 2.8(Statements only and applications)]; Chapter 3 - Sections: 3.1 & 3.2 (Theorem 3.4 only)			
4	4.1	Basic Properties of Congruence	5	

	4.2	Fermat's Theorem and Pseudoprimes	6	
	4.3	Wilson's Theorem	7	
	4.4	Euler's Phi Function and Theorem	8	
		Problems (Practicum)		
	Text 2: Chapter 4 – section: 4.2; Chapter 5 – Sections: 5.2 (Up to Theorem 5.2), 5.3 (Up to Theorem 5.5); Chapter 7 – Sections: 7.2 (Theorem 7.2-Statement only and applications) & 7.3			
5	**Teacher Specific Contents** (*This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**			

Practicum
● Practicum is designed to provide supervised practical application of theoretical knowledge and skills. ● Its purpose is to encourage creativity and develop Problem solving skills. ● The practicum component is to be done in the classroom under the strict guidance of the teachers. ● A minimum of 30 problems is to be solved, and a handwritten copy of the solutions should be kept in the department.

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)**		
	Lectures, Tutorials, Interactive Sessions, Blended Learning		
	MODE OF ASSESSMENT		
	A	**Continuous Comprehensive Assessment (CCA) [30 marks]**	
		Components	**Mark Distribution**
		Module Test- I	**5** Marks
		Module Test- II	**5** Marks

<table>
<tr><td rowspan="4">Assessment Types</td><td rowspan="4"></td><td colspan="4">Module Test- III</td><td>5 Marks</td></tr>
<tr><td colspan="4">Module Test- IV</td><td>5 Marks</td></tr>
<tr><td colspan="4">Assignment/Seminar</td><td>5 Marks</td></tr>
<tr><td colspan="4">Quiz/Viva voce</td><td>5 Marks</td></tr>
<tr><td></td><td>B</td><td colspan="5">End Semester Evaluation (ESE)</td></tr>
<tr><td></td><td rowspan="10"></td><td colspan="5">Question Pattern
[Maximum Time 2 Hours, Maximum Marks 70]</td></tr>
<tr><td></td><td rowspan="2">Module</td><td>Part A</td><td>Part B</td><td>Part C</td><td rowspan="2">Total</td></tr>
<tr><td></td><td>1 Mark (MCQ)</td><td>5 Marks</td><td>10 Marks</td></tr>
<tr><td></td><td>I</td><td>5</td><td>2</td><td>1</td><td>8</td></tr>
<tr><td></td><td>II</td><td>5</td><td>2</td><td>1</td><td>8</td></tr>
<tr><td></td><td>III</td><td>5</td><td>2</td><td>1</td><td>8</td></tr>
<tr><td></td><td>IV</td><td>5</td><td>2</td><td>1</td><td>8</td></tr>
<tr><td></td><td>Total no of questions</td><td>20</td><td>8</td><td>4</td><td>32</td></tr>
<tr><td></td><td>Number of questions to be answered</td><td>20</td><td>6</td><td>2</td><td>28</td></tr>
<tr><td></td><td>Total Marks</td><td>20</td><td>30</td><td>20</td><td>70</td></tr>
</table>

TEXT BOOKS:

1. Blyth, T. S., and E. F. Robertson. Basic linear algebra. Springer, 2007.
2. Burton, David M.. Elementary number theory (7th ed.). McGraw-Hill Education, 2017.

SUGGESTED READINGS

- Strang, Gilbert. Introduction to linear algebra (5th ed.). Wellesley-Cambridge Press, 2016.
- Lipschutz, S., Lipson, M.. Schaum's outline of theory and problems of linear algebra (4th ed.). McGraw-Hill.
- Kumaresan, S. Linear Algebra: A Geometric Approach. PHI Learning.,2015.

- Bronston, T. A., Costa, A. C. R. . Linear algebra: An introduction (4th ed.). Academic Press, 2013.

ADVANCED READINGS

- Apostol, T. M. . An Introduction to Analytic Number Theory (2nd ed.). Springer, 1976.
- Niven, I., Zuckerman, H. S., Montgomery, H. L. An Introduction to Number Theory (5th ed.). Wiley, 1991.

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

➢ Proofs of theorems in Chapter 3 (up to exercise 3.10) and Chapter 4

➢ Use of computational software or tools (like Python, Sage math etc.) to perform the matrix operations in the modules 1 and 2

➢ Illustrate the technique of Sieve of Eratosthenes for finding all primes below a given integer (Chapter 3-Sec. 3.2 of Textbook 2)

➢ Apply Congruence relation to encrypt and decrypt a message using Caesar Cipher and Vigenere's approach. (Relevant Sections of Chapter 10 of Textbook 2)

➢ Proofs of theorems 2.3 and 2.4 of Textbook 2.

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<table>
<tr><td>Programme</td><td colspan="6">B Sc Mathematics</td></tr>
<tr><td>Course Name</td><td colspan="6">Fundamentals of Analysis</td></tr>
<tr><td>Type of Course</td><td colspan="6">Discipline Specific Component - DSC A</td></tr>
<tr><td>Course Code</td><td colspan="6">24SACMAT4DA202</td></tr>
<tr><td>Course Level</td><td colspan="6">200</td></tr>
<tr><td>Course Summary</td><td colspan="6">This course covers elementary properties of real and complex numbers, with a focus on analytic functions and various mathematical functions. Practical applications and problem-solving skills are emphasized throughout. The course provides an in-depth review of complex numbers, exploring their fundamental characteristics, exponential representations, and geometric importance. It delves into functions of complex variables, presenting the Cauchy-Riemann equations as a means of identifying analytic functions. The conclusion includes a comprehensive discussion of special functions of complex variables, such as inverse trigonometric and hyperbolic functions, as well as exponential, logarithmic, trigonometric, and hyperbolic functions.</td></tr>
<tr><td>Semester</td><td>4</td><td colspan="3">Credits</td><td>4</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Others</td></tr>
<tr><td>3</td><td>0</td><td>1</td><td>0</td><td>5</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="6">Basic Set theory and Calculus</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	To understand the basic principles of set theory, including definitions of finite and infinite sets, cardinality, and operations on sets.	U	1, 2
2	Demonstrate a comprehensive understanding of the real numbers as a complete ordered field, distinguishing their properties from those of other algebraic structures with similarities to real numbers.	A	1,2,3
3	Analyze the concept of completeness property in real numbers and apply the supremum property in mathematical analysis and problem-solving.	An	1,2,3, 10
4	Identify various numerical representations of real numbers and categorize different types of intervals.	An	1,2,3
5	Understand the basic properties of complex plane, its geometrical dimensions and complex functions	U	1,2,3, 10
6	Identify regions of complex plane and behaviour of continuous and differentiable functions of complex variables	A	1,2,3, 10
7	Analyse analytic and harmonic of functions of complex variables	An	1,2,3, 10
8	Categorise the basic properties of some elementary functions of complex variables.	An	1,2,3, 10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course Description	CO No:	Hours
1	1.1	Graphical visualization of Elementary Functions using *Geogebra/ Desmos*	1	**15**
	1.2	Finite and Infinite Sets.	1	

	1.3	The Algebraic and Order Properties of R.	2	
	1.4	Absolute Value and the Real Line.	2	
	Text 1: Chapter 1 - Section: 1.3 (Concepts, statements of the theorems, informal proofs and problems only); Chapter 2 - Sections:2.1 & 2.2.			
2	2.1	The Completeness property of R	3	**20**
	2.2	Applications of supremum property	3	
	2.3	Intervals	4	
		Problems (Practicum)	**3, 4**	
	Text 1: Chapter 2 - Sections: 2.3, 2.4 (Theorems 2.4.7 – Statement only), 2.5 (Concepts, statements of the theorems and problems only).			
3	3.1	Basic Properties of Complex Numbers	5	**20**
	3.2	Exponential form of Complex Numbers	5	
	3.3	Roots of Complex Numbers	5	
	3.4	Regions in the complex Plane	6	
	3.5	Functions of the complex Variables	5	
	3.6	Limits and Continuity	5	
	3.7	Differentiation of Complex functions and CR Equations	6	

	3.8	Analytic and Harmonic functions	7	
		Problems (Practicum)	**5, 6, 7**	
	Text 2: Sections: 1 to 12,15,16,18 to 22,24 to 26 (Concepts, statements of the theorems and problems only from sections 16, 21 and 22)			
4	4.1	Exponential functions	8	**20**
	4.2	Logarithmic functions	8	
	4.3	Trigonometric and Hyperbolic functions	8	
	4.4	Inverse Trigonometric and Hyperbolic functions	8	
		Problems (Practicum)	8	
	Text 2: Sections: 29 to 32, 34 to 36			
5	**Teacher Specific Contents** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**			

Practicum
• Practicum is designed to provide supervised practical application of theoretical knowledge and skills. • Its purpose is to encourage creativity and develop Problem solving skills. • The practicum component is to be done in the classroom under the strict guidance of the teachers. • A minimum of 30 problems is to be solved, and a handwritten copy of the solutions should be kept in the department.

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)**					
	Lecture, Tutorial and Activity oriented					
Assessment Types	**MODE OF ASSESSMENT**					
	A	**Continuous Comprehensive Assessment (CCA) [30 marks]**				
		Components			**Mark Distribution**	
		Module Test- I			**5** Marks	
		Module Test- II			**5** Marks	
		Module Test- III			**5** Marks	
		Module Test- IV			**5** Marks	
		Assignment/Seminar			**5** Marks	
		Quiz/Viva voce			**5** Marks	
	B	**End Semester Evaluation (ESE)**				
		Question Pattern [Maximum Time 2 Hours, Maximum Marks 70]				
		Module	Part A **1 Mark (MCQ)**	Part B **5 Marks**	Part C **10 Marks**	Total
		I	5	2	1	**8**
		II	5	2	1	**8**
		III	5	2	1	**8**
		IV	5	2	1	**8**
		Total no of questions	**20**	**8**	**4**	**32**
		Number of questions to be answered	**20**	**6**	**2**	**28**
		Total Marks	**20**	**30**	**20**	**70**

TEXT BOOKS:

1. Bartle, Robert G., Sherbert, Donald R. *Introduction to Real Analysis (4th Edition)*, Wiley Internationals, 2000.
2. Brown, James Ward., Churchil, Ruel V. *Complex Variables and Applications (8th Edition)*, McGraw- Hill Publications, 2009

SUGGESTED READINGS:

1. Denlinger, Charles. *Elements of real analysis*. Jones & Bartlett Learning, 2011.
2. Abbott, Stephen. *Understanding analysis*. springer publication, 2015.
3. Ghorpade, Sudhir R., and Balmohan Vishnu Limaye. *A course in calculus and real analysis*. New York: Springer, 2006.
4. Kumar, Ajit, Kumaresan, S. *A basic course in real analysis*. CRC press, 2014.
5. Ponnusamy, S., Herb Silverman. *Complex variables with applications*. Springer Science & Business Media, 2007.
6. Krantz, Steven G. *Complex Variables: a physical approach with applications and MATLAB*. CRC Press, 2007.
7. Kasana, Harvir Singh. *Complex variables: theory and applications*. PHI Learning Pvt. Ltd., 2005.
8. Zill, Dennis G., and Patrick D. Shanahan. *Complex analysis: A first course with applications*. Jones & Bartlett Publishers, 2013.
9. Choudhary, B. *The elements of complex analysis*. New Age International, 1993.

ADVANCED READINGS:

1. Howie, John M. *Real analysis*. Springer Science & Business Media, 2006.
2. Rudin, Walter. *Principles of mathematical analysis*. Vol. 3. New York: McGraw-hill, 1976.
3. Royden, Halsey Lawrence, and Patrick Fitzpatrick. *Real analysis*. Vol. 2. New York: Macmillan, 1968.
4. Saff, E. B., Snider, A. D. *Fundamentals of Complex Analysis with Applications to Engineering, Science and Mathematics*, (2002).
5. Jeffrey, Alan. *Complex analysis and applications*. CRC Press, 2005.

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- Principle of strong mathematical induction.
- Well ordering property
- Check whether C satisfies the completeness property.
- Binary representation and decimal representation of real numbers.
- Plot and analyse complex functions using available software.
- Applications of complex numbers and complex functions in different areas.
- Studies on multi valued complex functions
- Formal proofs of theorems in section 1.3
- Proof of theorem 2.4.7
- Proof of theorems in section 2.5

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<table>
<tr><td>Programme</td><td colspan="6">B Sc Mathematics</td></tr>
<tr><td>Course Name</td><td colspan="6">Operations Research</td></tr>
<tr><td>Type of Course</td><td colspan="6">Discipline Specific Elective – DSE</td></tr>
<tr><td>Course Code</td><td colspan="6">24SACMAT4DE201</td></tr>
<tr><td>Course Level</td><td colspan="6">200</td></tr>
<tr><td>Course Summary</td><td colspan="6">The objective of this course is to familiarize industrial problems to students with various methods of solving Linear Programming Problems, Transportation Problems, Assignment Problems and their applications</td></tr>
<tr><td>Semester</td><td>4</td><td colspan="3">Credits</td><td>4</td><td rowspan="2">Total Hours/ Week</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Others</td></tr>
<tr><td>4</td><td>0</td><td>0</td><td>0</td><td>4</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="6"></td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
	Upon the successful completion of the course, the student will be able to		
1	Express objective function and resource constraints in LP model in terms of decision variables and parameters.	U	1,2,3
2	Solve an LP problem by the graphical method.	A	2
3	Interpret the optimal solution of LP problems.	A	2,6,10
4	Formulate the dual LP problem and understand the relationship between primal and dual LP problems.	U	1,2,3
5	Recognize, formulate, and solve a transportation problem involving a large number of shipping routes.	C	1,2,3,6,10

6	Analyse assignment problem and apply the Hungarian method to solve an assignment problem.	**C**	**1,2,3**
***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)**			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	**Units**	**Course description**	**CO No.**	**Hours**
1	1.1	Linear Programming: Introduction, Formulation of LPP (Example up to 2.6.10)	1	**12**
	1.2	Graphical Method of Solution (Example up to 2.9.8)	2	
	1.3	**a)** Some Exceptional Cases	2	
	1.4	b) The General LPP, Canonical and Standard Forms of LPP	1	
	Text 1: Chapter 2 - Sections: 2.1, 2.6, 2.9 to 2.12			
2	2.1	Simplex Method: Theory of Simplex Method, Some Important Definitions	3	**18**
	2.2	The Simplex Method (Example up to 2.16.4)	3	
	2.3	Artificial Variable Techniques: Big-M Method only (Example up to 2.17.4)	3	
	2.4	Special Cases in Simplex Method Application	3	
	2.5	Duality in Linear Programming	4	
	Text 1: Chapter 2 - Sections: 2.13, 2.14, 2.16, 2.17, 2.18.1 to 2.18.6; Chapter 6 - Sections: 6.1.1 to 6.1.3(problems, theorems without proof)			
3	3.1	Transportation Problem: Introduction to the Model, Assumptions in the Transportation Model, Definitions of the Transportation Model, Matrix Terminology	5	**16**

	3.2	Formulation and Solution of Transportation Model	**5**	
	3.3	Variants in Transportation Problem	**5**	
	Text 1: Chapter 3 - Sections: 3.1 to 3.4, 3.5.1,3.5.2, 3.6.1,3.6.2			
4	4.1	Assignment Problem: Definition of the Assignment Model, Mathematical Representation of Assignment Model, Comparison with the Transportation Model	6	**14**
	4.2	Solution of the Assignment Model	6	
	4.3	Hungarian Method for Solution of the Assignment Problems	6	
	4.4	Formulation and Solution of the Assignment Model	6	
	4.5	Variation of Assignment Problem: Non-square Matrix and Maximization Problem	6	
	Text 1: Chapter 4 - Sections: 4.1 to 4.7			
5	**Teacher Specific Contents** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**			

Practicum
• Practicum is designed to provide supervised practical application of theoretical knowledge and skills. • Its purpose is to encourage creativity and develop Problem solving skills. • The practicum component is to be done in the classroom under the strict guidance of the teachers. • A minimum of 30 problems is to be solved, and a handwritten copy of the solutions should be kept in the department.

<table>
<tr><th rowspan="2">Teaching and Learning Approach</th><th colspan="6">Classroom Procedure (Mode of transaction)</th></tr>
<tr><td colspan="6">Lecture, Teaching, Interactive Instruction, Seminar, Group Assignment, Library Work and Group Discussion</td></tr>
<tr><td rowspan="22">Assessment Types</td><td colspan="6">MODE OF ASSESSMENT</td></tr>
<tr><td>A</td><td colspan="5">Continuous Comprehensive Assessment (CCA) [30 marks]</td></tr>
<tr><td rowspan="7"></td><td colspan="3">Components</td><td colspan="2">Mark Distribution</td></tr>
<tr><td colspan="3">Module Test- I</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test- II</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test- III</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test- IV</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Assignment/Seminar</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Quiz/Viva voce</td><td colspan="2">5 Marks</td></tr>
<tr><td>B</td><td colspan="5">End Semester Evaluation (ESE)</td></tr>
<tr><td rowspan="11"></td><td colspan="5">Question Pattern
[Maximum Time 2 Hours, Maximum Marks 70]</td></tr>
<tr><td rowspan="2">Module</td><td>Part A</td><td>Part B</td><td>Part C</td><td rowspan="2">Total</td></tr>
<tr><td>1 Mark (MCQ)</td><td>5 Marks</td><td>10 Marks</td></tr>
<tr><td>I</td><td>5</td><td>2</td><td>1</td><td>8</td></tr>
<tr><td>II</td><td>5</td><td>2</td><td>1</td><td>8</td></tr>
<tr><td>III</td><td>5</td><td>2</td><td>1</td><td>8</td></tr>
<tr><td>IV</td><td>5</td><td>2</td><td>1</td><td>8</td></tr>
<tr><td>Total no of questions</td><td>20</td><td>8</td><td>4</td><td>32</td></tr>
<tr><td>Number of questions to be answered</td><td>20</td><td>6</td><td>2</td><td>28</td></tr>
<tr><td>Total Marks</td><td>10</td><td>30</td><td>30</td><td>70</td></tr>
</table>

TEXT BOOK:

1. Prem Kumar Gupta., Hira, D.S. *Operations Research – 7th Edition*, S Chand & Sons Publications, 2014.

SUGGESTED READINGS:

- Sharma, J.K. *Operations Research: Theory and Applications – 6th edition*, Macmillian India Ltd-New Delhi Publications
- Frederick S. Hillier., Gerald J Lieberman. *Introduction to Operations Research* – 10th edition. McGraw Hill Publications.
- Taha , Hamdy A. *Operations Research: An Introduction – 8th edition.* Pearson Education Publishers.
- Kanti Swarup., Gupta, P.K., Man Mohan. *Operation Research*. S Chand & Sons Publications
- Aumann R.J. *Mixed and Behaviour strategies in infinite extensive.* Princeton University.

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

Problem solving using the methods discussed in the module 1, 2 and 3

Department of Mathematics St. Albert's College (Autonomous) Ernakulam

Programme	**B. Sc. Chemistry, B. Sc. Physics, B. Sc. Geology, B. Sc. Statistics etc.**
Course Name	**Essential Mathematics for Science**
Type of Course	**Discipline Specific Component (DSC C)**
Course Code	**24SACMAT4DB201 / 24SACMAT4DC201**
Course Level	**200**
Course Summary	This Mathematics minor course complements and enhances the undergraduate programmes on science disciplines such as Physics, Chemistry etc., by enabling the students to understand the concepts of complex numbers and analytic functions, to solve differential equations of different types, to identify different conic sections and its applications in possible areas and to determine unit tangent vector, principal normal vector, and curvature of different curves.

Semester	**4**	Credits			**4**	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	0	1	0	**5**
Pre-requisites, if any	Basic awareness of coordinate systems, vectors, functions, derivatives, and integrals					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
	Upon the successful completion of the course, the student will be able to		
1	Understand the concepts of complex functions and vector calculus	K	1
2	Apply C-R equations to check the analyticity of complex functions	A	2
3	Analyse the nature of differential equation	An	1
4	Solve equations in complex variables and differential equations	A	2

5	Distinguish between cartesian and polar co- ordinates	An	1
6	Identify conic sections from its equations and Visualize curves	E	2
7	Find the curvature and directional derivatives of curves	E	2
8	Develop applications of mathematical concepts in scientific/real life problems	C	3
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course Description	Hrs	CO No.
1		**Complex Functions**	**20**	
	1.1	Complex Numbers, Sums and Products, Basic Algebraic Properties, moduli, conjugates, Exponential and Polar Forms, Products and Powers in Exponential form	6	1
	1.2	Functions of Complex Variables, Separation into Real and Imaginary parts, Limits and Continuity	5	1
	1.3	Derivatives, Analytic Function, Cauchy-Riemann Equations, Laplace Equation, Harmonic Function	6	2
		Problems (Practicum)	3	1, 2
		Text 1: Chapter 1 – Sections: 1 to 7; Chapter 2 – Sections: 12,15,16,18 to 22, 24 to 26. Theorems – Statements Only		
2		**Differential Equations**	**18**	
	2.1	Degree, Order, Solution of Differential Equations, Variable Separable method	6	3, 4
	2.2	Exact Differential Equations	5	3, 4
	2.3	Linear Differential Equations, Bernoulli's Equations	5	4
		Problems (Practicum)	2	3, 4

		Text 2: Chapter 1 – Sections: 1.1 to 1.5 Theorems – Statements Only		
3		**Analytic Geometry**	**17**	
	3.1	Polar coordinates	5	5
	3.2	Conic sections	4	6
	3.3	Conic section in polar coordinates	4	6
		Problems (Practicum)	4	5,6
		Text 3: Chapter 11 – sections: 11.3,11.6 & 11.7 Theorems – Statements Only		
4		**Vector Calculus**	**20**	
	4.1	Curves in Space and tangents, Velocity and Acceleration, Arc length in space	6	1, 8
	4.2	Curvature and Normal vectors of a curve	5	1, 7
	4.3	Directional derivatives and gradient vectors	5	1, 7
		Problems (Practicum)	4	1,7,8
		Text 3: Chapter 13 – Sections: 13.1, 13.3, 13.4; Chapter 14 – Section: 14.5. Theorems – Statements Only		
5	**Teacher Specific Contents** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**			

Practicum
● Practicum is designed to provide supervised practical application of theoretical knowledge and skills. ● Its purpose is to encourage creativity and develop Problem solving skills. ● The practicum component is to be done in the classroom under the strict guidance of the teachers. ● A minimum of 30 problems is to be solved, and a handwritten copy of the solutions should be kept in the department.

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<tr><td rowspan="7"></td><td colspan="3">Components</td><td colspan="2">Mark Distribution</td></tr>
<tr><td colspan="3">Module Test- I</td><td colspan="2">5 Marks</td></tr>
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<tr><td>B</td><td colspan="5">End Semester Evaluation (ESE)</td></tr>
<tr><td rowspan="8"></td><td colspan="5">Question Pattern
[Maximum Time 2 Hours, Maximum Marks 70]</td></tr>
<tr><td rowspan="2">Module</td><td>Part A</td><td>Part B</td><td>Part C</td><td rowspan="2">Total</td></tr>
<tr><td>1 Mark (MCQ)</td><td>5 Marks</td><td>10 Marks</td></tr>
<tr><td>I</td><td>5</td><td>2</td><td>1</td><td>8</td></tr>
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<tr><td>Total no of questions</td><td>20</td><td>8</td><td>4</td><td>32</td></tr>
</table>

		Number of questions to be answered	**20**	**6**	**2**	**28**
		Total Marks	**20**	**30**	**20**	**70**

TEXT BOOKS:

4. James Ward Brown, Ruel V. Churchill. *Complex Variables and Applications, Eighth Edition*, McGraw Hill, *2009*
5. Simmons, G.F., Krantz, S.G. *Differential Equations*, Tata McGraw Hill-New Delhi, 2007.
6. Thomas, George B Jr. *Thomas' Calculus, Twelfth Edition*, Pearson, 2010

REFERENCES:

5. Grewal, B. S., *Higher Engineering Mathematics*, *44th Edition*, Khanna Publishers, 2021.
6. Anton, H., Bivens, Devis. *Calculus, tenth Edition*, Wiley India.
7. Kreyszig,E. *Advanced Engineering Mathematics*, Wiley, India.
8. Siddiqi, A.H., Manchanada, P. *A first course in Differential Equations*, Mc Millan.

SUGGESTED READINGS:

- Proofs of theorems from module 1, 2, 3 & 4
- Solution of equations in Complex variables, Regions in the Complex plane
- Homogeneous Differential equations, Integrating Factors of Differential Equations
- Visualization of curves and conic section, Obtaining Points of farthest and closest approach of Planets/ Satellites
- Integration in vector fields, Finding Work done, Flow, circulation and flux
- Text 1-Chapter 1 (Roots of complex numbers, Regions in complex plane)
- Text 2 – Chapter 1 (Homogeneous Differential Equations, Integrating factors)
- Text 3 – Chapter 16 (Line integrals, Work, Circulation and Flux)

Department of Mathematics
St. Albert's College (Autonomous) Ernakulam

Programme	**BA Economics and B Com**					
Course Name	**Mathematics for Business and Economics**					
Type of Course	**Discipline Specific Component (DSC C)**					
Course Code	**24SACMAT4DB202 / 24SACMAT4DC202**					
Course Level	**200**					
Course Summary	Mathematical methods and theories applicable in economics and business to analyse real life problems are included in the course. First module provides an understanding of the way in which financial calculations are worked out. Second module deals with different methods of solving systems of equations and the many varied applications of such systems to business and economics. Optimization of functions using their derivatives is included in the third module. Linear programming is helpful in business and economics where it is often necessary to optimize a profit or cost function subject to several inequality constraints. The graphic approach for maximization and minimization linear programming problems is also illustrated. Module four deals with the applications of calculus in economics and business.					
Semester	**4**	**Credits**			**4**	
Course Details	**Learning Approach**	Lecture	Tutorial	Practicum	Others	Total Hours/ week
		3	0	1	0	**5**
Pre-requisites, if any	Graphing functions, Basics of differential and integral Calculus, Multi-variable functions and partial differentiation, Percentage calculation, Basics of logarithmic and exponential functions					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
	Upon the successful completion of the course, the student will be able to		
1	Understand the difference between simple and compound interest	U	1,3
2	Calculate the future value of a principal under annual compounding and under continuous compounding	A	2,3
3	Recognize a geometric progression	K	2
4	Evaluate a geometric series and calculate the total investment obtained from a regular savings plan.	E	2,3,10
5	Use net present values to appraise investment projects and calculate the internal rate of return, the present value of an annuity	A	2,3,10
6	Use discounting to compare investment projects	U, A	1,3
7	Understand functions, classical optimization techniques and marginal concepts in economics	U	1,3
8	Analyse the real-life problems in business and economics and to model it mathematically	A, An, C	2,3,6,10
9	Apply elementary algebra and calculus in economics and business problems and solve it mathematically	A, C	1,2,3
10	Solve linear programming problem using graphical method	C	2
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	CO No.	Hours
1		**Mathematics of Finance**		**15**
	1.1	Compound Interest	1,2	

	1.2	Geometric Series	3,4	
	1.3	Investment Appraisal	5,6	
		Problems (Practicum)	1,2,3,4, 5,6	
	Text 2: Chapter 3 – Sections: 3.2 to 3.4			
2		**Mathematical Economics**		20
	2.1	Introduction to System of Equations	7	
	2.2	Graphical Solutions	7,8	
	2.3	Supply-and-Demand Analysis	8,9	
	2.4	Break-Even Analysis	8,9	
	2.5	Elimination and Substitution Methods	8,9	
	2.6	Income Determination Models	8,9	
	2.7	IS-LM Analysis	8,9	
		Problems (Practicum)	7,8,9	
	Text 1: Chapter 4 – Sections: 4.1 to 4.7			
3		**Optimization Techniques**		25

	3.1	Use of Graphs in LPP, Maximization Using Graphs	7,10	
	3.2	The Extreme-Point Theorem, Minimization Using Graphs	7,10	
	3.3	Optimization of Functions, The Successive-Derivative Test	7	
	3.4	Marginal Concepts in Economics	7,8,9	
	3.5	Optimizing Economic Functions for Business	8,9	
	3.6	Relationship Among Total, Marginal, and Average Functions	9	
		Problems (Practicum)	7,8,9,10	
	Text 1: Chapter 7 – Sections: 7.1 to 7.4; Chapter 10 – Sections: 10.6 to 10.10			
4		**Applications of Mathematics in Economics and Business**		**15**
	4.1	Functions of Several Independent Variables	7	
	4.2	Constrained Optimization problems with Lagrange Multipliers	7,8,9	
	4.2	Applications of definite integral in consumers and producers surplus	8,9	
		Problems (Practicum)	7,8,9	
	Text 1: Chapter 12 – Section: 12.11; Chapter 13 – Sections: 13.1 & 13.6			
5	**Teacher Specific Contents** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**			

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</table>

TEXT BOOKS:

3. Edward T Dowling, *Mathematical Methods for Business and Economics*, Schaum'sOutline Series, McGraw Hill, 2009.
4. Ian Jacques, *Mathematics for Economics and Business*, 5th Edition, Prentice Hall,2006.

SUGGESTED READINGS:

5. Taro Yamne, *Mathematics for Economists-An elementary survey*, Prentice -Hall, Inc.
6. Robert Brechner, *Contemporary Mathematics for Business and Consumers*, Fifth Edition
7. Das, N. G., Das, J K. *Business Mathematics and Statistics*, Tata McGraw-Hill, 2012.
8. Martin Anthony, Norman Biggs, *Mathematics for economics and finance Methods and Modelling*, Cambridge University Press, 2012.

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- Application mathematics in economics and business using spreadsheets

Department of Mathematics St. Albert's College (Autonomous) Ernakulam

Programme	**B Sc Computer Science**					
Course Name	**Essential Mathematics for Computing**					
Type of Course	**Discipline Specific Component (DSC C)**					
Course Code	**24SACMAT4DB203 / 24SACMAT4DC203**					
Course Level	**200**					
Course Summary	This course provides a comprehensive introduction to discrete mathematics and algorithms, covering topics such as number theory, cryptography, Boolean algebra, logic gates, relations, tree structures and graph theory. Practical implementation involves coding tree traversal, depth-first search and breadth-first search algorithms using a programming language. Students gain both theoretical insights and hands -on experience applicable across computer science domains.					
Semester	**4**	**Credits**			**4**	
Course Details	**Learning Approach**	Lecture	Tutorial	Practicum	Others	Total Hours/ week
		3	0	1	0	5
Pre-requisites, if any	Basic understanding of integers and divisibility, basic algebraic operations, set theory and set operations and basic graph theory concepts.					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
	Upon the successful completion of the course, the student will be able to		

1	Understand the fundamental concepts of number theory, including prime numbers and divisibility	U	2
2	Apply congruence in various mathematical scenarios and recognize its applications in Hashing and Cryptography.	A	8
3	Analyze the truth tables and logical operations associated with each type of logic gates.	An	1
4	Understand the relations and it's representations	U	2
5	Apply the basic concepts of trees and tree traversal techniques	A	2
6	Apply knowledge of spanning trees and understand their applications in different domains	A	3
7	Analyze the security implications and practical applications of the RSA cryptosystem	An	8
8	Apply tree traversal algorithm, depth-first search algorithm and breadth-first search algorithm to solve real world problems , using any suitable programming language.	C	9
***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)**			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	CO No.	Hours
1		**Number theory & Cryptography**		
	1.1	Divisibility and modular arithmetic:- Division, Division algorithm, Modular arithmetic, Congruence and Basic properties of congruence.	1,2	
	1.2	Primes and Greatest common divisor :- Primes, Fundamental theorem of arithmetic (statement and problems only), Greatest common divisors and least common multiples, Euclidean	2	**17**

		algorithm, g.c.d as linear combination		
	1.3	Applications of number theory: a) Solving congruence :- Linear congruence, Chinese remainder theorem and Fermat's theorem (Statement only) b) Application of congruence :- Hashing function	2	
		c) Cryptography :- Caesar cipher, Vignere cipher and Hill cipher		
		Problems (Practicum)	1,2	
	Text 1: Chapter 4 – Sections: 4.1, 4.3 to 4.6 **Text 2: Chapter 10 – Section: 10.1**			
2		**Boolean algebra**		
	2.1	Boolean functions	3	13
	2.2	Representing of Boolean functions Sum Of Products (SOP)	3	
	2.3	Logic gates	3	
		Problems (Practicum)	3	
	Text 1: Chapter 11 – Sections: 11.1 to 11.3			
3		**Relations & Partial orders**		
	3.1	Relations & properties	4	20
	3.2	Representing relations	4	

	3.3	Equivalence relation	4	
	3.4	Partial ordering & Hasse Diagrams	4	
		Problems (Practicum)	4	
	Text 1: Chapter 8 – Sections: 8.1, 8.3, 8.5 & 8.6			
4		**Trees**		
	4.1	Introduction to trees:- Trees, Properties of trees, Applications of trees:- Binary search trees, Prefix codes and Huffman coding	5	**25**
	4.2	Tree traversal:- Traversal algorithms, Infix, Prefix and postfix notations	7,8	
	4.3	Spanning trees: - Introduction, Depth-first search algorithm (BFS), Breadth--first search algorithms (DFS)	5	
	4.4	Minimum spanning trees:- Algorithms for minimum spanning trees- Kruskal's algorithm and Prim's algorithm	6	
		Problems (Practicum)	5,6,7,8	
	Text 1: Chapter 10 – Sections: 10.1 to 10.5			
5	**Teacher Specific Contents** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**			

Practicum
• Practicum is designed to provide supervised practical application of theoretical knowledge and skills. • Its purpose is to encourage creativity and develop Problem solving skills. • The practicum component is to be done in the classroom under the strict guidance of the teachers. • A minimum of 30 problems is to be solved, and a handwritten copy of the solutions should be kept in the department.

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)**					
	Direct instruction: Lecture Method, Tutorial ,Brainstorming Lectures, Explicit Teaching Interactive instructions: Active Cooperative Learning, Library Work and Group Discussion, Peer Learning, Authentic Learning					
Assessment Types	**MODE OF ASSESSMENT**					
	A	**Continuous Comprehensive Assessment (CCA) [30 marks]**				
		Components			**Mark Distribution**	
		Module Test- I			5 Marks	
		Module Test- II			5 Marks	
		Module Test- III			5 Marks	
		Module Test- IV			5 Marks	
		Assignment/Seminar			5 Marks	
		Quiz/Viva voce			5 Marks	
	B	**End Semester Evaluation (ESE)**				
		Question Pattern [Maximum Time 2 Hours, Maximum Marks 70]				
		Module	Part A	Part B	Part C	Total
			1 Mark (MCQ)	**5 Marks**	**10 Marks**	
		I	5	2	1	**8**
		II	5	2	1	**8**

		III	5	2	1	**8**
		IV	5	2	1	**8**
		Total no of questions	**20**	**8**	**4**	**32**
		Number of questions to be answered	**20**	**6**	**2**	**28**
		Total Marks	**20**	**30**	**20**	**70**

TEXT BOOKS:

3. Kenneth H Rosen, *Discrete Mathematics and its Applications (Eighth Edition)*, Tata McGraw- Hill Education (India) private limited, Special Indian Edition 2021.
4. Burton, David M. *Elementary Number theory (Seventh edition)*, The McGraw Hill companies, 2009.

SUGGESTED READINGS:

4. Clifford Stien., Robert L Drysdale., Kenneth Bogart. *Discrete Mathematics for computer scientists*; Pearson Education; Dorling Kindersley India Pvt Ltd.
5. Kenneth A Ross., Charles R.B.Wright., *Discrete Mathematics*; Pearson Education; Dorling Kindersley India Pvt Ltd.
6. Richard Johnsonbaugh. *Discrete Mathematics*. Pearson Education; Dorling Kindersley India Pvt Ltd.

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- RSA public key cryptosystem
- Implement tree traversal algorithm, depth-first search algorithm and breadth-first search algorithm using any suitable programming language.
- Text 1-4.6, 10.3, 10.4
- Text 2- Section 10.1

Department of Mathematics
St. Albert's College (Autonomous) Ernakulam

Programme	**BBA**
Course Name	**Mathematics for Management**
Type of Course	**Discipline Specific Component (DSC C)**
Course Code	**24SACMAT4DB204 / 24SACMAT4DC204**
Course Level	**200**
Course Summary	The fundamental topics covered in business mathematics are Ratios and Proportion Variation, Indices, Permutation and Combinations Linear Simultaneous Equations Simple and Compound interest including the application of Annuity.

Semester	**4**	**Credits**			**4**	
Course Details	**Learning Approach**	Lecture	Tutorial	Practicum	Others	Total Hours/ week
		3	0	1	0	**5**
Pre-requisites, if any						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
	Upon the successful completion of the course, the student will be able to		
1	Grasping the fundamental principles of Permutations and combinations.	U	3

2	Developing problem solving skills involving arrangements, selections and distributions.	S	8
3	Ability to interpret and analyse financial data presented in various formats.	An	2
4	Understanding how matrices are applied in diverse fields like statistics, optimization, and data analysis.	A	7
5	Students should be able to comprehend and represent matrices using mathematical notation, and understand their properties and operations.	R	3
6	Proficiency in solving systems of linear equations using matrices and determinants. This includes the application of matrices in solving real-world problems related to linear systems.	E	6
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course Description	CO No:	Hours
1		**Algebra**		15
	1.1	Variation	1	
	1.2	Permutations	1	
	1.3	Combinations	1	
		Problems (Practicum)	1	
	Text 1: Chapter 8. **Text 2: Chapter 6 – Section: 6.3**			

2		**Progressions and Commercial Arithmetic**		**20**
	2.1	Percentage	2	
	2.2	Profit and Loss	**2**	
	2.3	Simple interest, Compound interest	**3**	
		Problems (Practicum)	**2,3**	
	Text 1: Chapter 10,11,14 & 15			
3		**Fundamental topics in Geometry and Mathematics**		**15**
	3.1	Rectangular Co-ordinates	**2**	
	3.2	Straight lines-Point slope form,1-point form,2- point form, Intercept form, General equation to other forms.	**2**	
	3.3	Angle between two lines, Condition for parallelism and perpendicular.	**2**	
		Problems (Practicum)	**2**	
	Text 3: Chapter 1 – Sections: 1 to 4, Chapter 2 – Sections: 1,2,3,5,7, 9(9.1,9.2 only)			
4		**Matrix and Measurement**		**25**
	4.1	Concept of a matrix, algebra of matrices	**5**	

	4.2	Determinant of a square matrix- Expansion only.	**5**	
	4.3	Solution of a system of linear equations up to three variable using Cramer's Rule	6	
		Problems (Practicum)	5	
	Text 4: Chapter 1,2 & 8			
5	**Teacher Specific Contents** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**			

Practicum
• Practicum is designed to provide supervised practical application of theoretical knowledge and skills. • Its purpose is to encourage creativity and develop Problem solving skills. • The practicum component is to be done in the classroom under the strict guidance of the teachers. • A minimum of 30 problems is to be solved, and a handwritten copy of the solutions should be kept in the department.

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	Direct Instruction: Brain Storming Lecture, Explicit Teaching, E-learning Interactive Instruction: Active Co-operative Learning, Seminar, Group Assignments, Authentic Learning, Library Work and Group Discussion, Presentation by Individual Student/ Group Representative		
	MODE OF ASSESSMENT		
	A	**Continuous Comprehensive Assessment (CCA) [30 marks]**	
		Components	**Mark Distribution**
		Module Test- I	**5** Marks
		Module Test- II	**5** Marks

Assessment Types		Module Test- III	**5** Marks
		Module Test- IV	**5** Marks
		Assignment/Seminar	**5** Marks
		Quiz/Viva voce	**5** Marks
	B	**End Semester Evaluation (ESE)**	
		Question Pattern **[Maximum Time 2 Hours, Maximum Marks 70]**	

Module	Part A **1 Mark (MCQ)**	Part B **5 Marks**	Part C **10 Marks**	Total
I	5	2	1	**8**
II	5	2	1	**8**
III	5	2	1	**8**
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Total no of questions	**20**	**8**	**4**	**32**
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Total Marks	**20**	**30**	**20**	**70**

TEXT BOOKS:

5. M.Tyra and K.Kundan, Concept of Arithemetic for Competitive exams, BSC Publishing Co.Pvt.Ltd, New Delhi, 2011.
6. Rosen, Kenneth H. *Discrete Mathematics and Its Applications* (7th ed.). McGraw Hill Publishing Co. New Delhi, 2013.
7. T.K. Manicavachagom Pillay; T.Natarajan; Analytical Geometry, S.Viswanathan, Pvt.Ltd,2008.
8. M.L Khanna, Algebra, Jai Prakash Nath and Co. Educational Publishers, Meerut.

SUGGESTED READINGS:

3. Sancheti, D. C., & Kapoor, V. K. (2009). *Business Mathematics*. New Delhi: Sultan Chand and Sons.
4. S. Saha, *Business Mathematics and statistics.* NCBA, 2010.

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- Familiarise the students the concept of Computing present value of annuities.
- Solve linear equations without using Cramer's rule.

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<table>
<tr><td>Programme</td><td colspan="6">B. Sc. Mathematics</td></tr>
<tr><td>Course Name</td><td colspan="6">Business Mathematics</td></tr>
<tr><td>Type of Course</td><td colspan="6">Foundation Component - VAC</td></tr>
<tr><td>Course Code</td><td colspan="6">24SACMAT4VA201</td></tr>
<tr><td>Course Level</td><td colspan="6">200</td></tr>
<tr><td>Course Summary</td><td colspan="6">This course provides a solid foundation in mathematical concepts relevant to business applications. The inclusion of practical lab sessions using Excel enhances the understanding of these concepts through hands-on experience and real-world problem-solving. Students will gain proficiency in applying mathematical tools to analyse economic scenarios, make informed decisions, and solve business-related problems.</td></tr>
<tr><td>Semester</td><td>4</td><td colspan="3">Credits</td><td>3</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Others</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="6">-</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
	Upon the successful completion of the course, the student will be able to		
1	Perform various matrix operations	A	2
2	Formulate real life problems into matrix and solve	C	1, 6
3	Sketch graphs of linear equations and solve simultaneous equations using graphical method	A	2
4	Formulate and solve system of linear equations from real life problems	C	2, 6
5	Apply excel spreadsheet functions to perform matrix operations and to solve simultaneous equations and	A, S	3, 6 10

	linear programming problems		
6	Learn Freehand Method, Semi-average method, Moving average method & Method of Least squares to analyse underlying causes of trends or systematic patterns over time.	An, A	1, 2, 3, 6, 10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1		**Matrix Algebra**		
	1.1	Basic principles of matrix multiplication, Matrix multiplication – the general case (using excel)	2	1
	1.2	Matrix multiplication – the general case (using excel)	2	1, 5
	1.3	The matrix inverse and the solution of simultaneous equations	2	1, 2
	1.4	Determinants (using excel)	2	1, 5
	1.5	Minors, cofactors and the Laplace expansion	2	1
	1.6	The transpose matrix, the cofactor matrix, the adjoint and the matrix inverse formula (Exclude the derivation of the matrix-inverse formula)	2	1
	1.7	solution of linear simultaneous equations (using excel)	2	2, 5
	1.8	Cramer's rule	2	2
	1.9	Input- Output Analysis	2	2
		Text 1: Chapter 15 - Sections 15.1 to 15.9 & 15.12		
2		**Linear Programming Problems**		

	2.1	Linear Equations: Straight line graphs, An Economic Application- Supply and Demand	4	3
	2.2	Simultaneous Equations	3	3
	2.3	Linear Inequalities: Inequalities & Economic Applications	4	3
	2.4	Linear Programming - Formulation and Graphic Solution (using excel)	4	4, 5
		Text 2: Chapter 1 – Sections: 1.1, 1.2, 1.3 (Excluding Complications, Three Equations in Three Unknowns and Gaussian Elimination); Chapter 2 – Sections: 2.1 & 2.2 **Text3: Chapter 2 (excluding section 2.5)**		
3		**Interpolation and Time Series Analysis**		
	3.1	Time Series, Necessity of time series analysis	4	6
	3.2	Components of time series, Some adjustments of time series data	4	6
	3.3	Measurement of trend: Freehand Method, Semi-average method, Moving average method, Method of Least squares. (Linear Trend only)	4	6
		Text 4: Chapter 18 - Sections 18.1 to 18.8		
4	**Teacher Specific Contents** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**			

Practicum
• Practicum is designed to provide supervised practical application of theoretical knowledge and skills. • Its purpose is to encourage creativity and develop Problem solving skills. • The practicum component is to be done in the classroom under the strict guidance of the teachers.

- A minimum of 30 problems is to be solved, and a handwritten copy of the solutions should be kept in the department.

<table>
<tr><td rowspan="2">Teaching and Learning Approach</td><td colspan="5">Classroom Procedure (Mode of transaction)</td></tr>
<tr><td colspan="5">Verbal Exposition
Case Studies: Applying matrix algebra to business scenarios.
In-Class Demonstrations: Visualizing matrix operations in action.
Think-Pair-Share Activities: Encouraging peer collaboration in understanding concepts.
Flipped Classroom Approach: Pre-learning materials before class discussions.
Scenario-based Learning: Learning through hypothetical business scenarios.
Online Quizzes and Exercises: Reinforcing learning through practice.</td></tr>
<tr><td rowspan="16">Assessment Types</td><td colspan="5">MODE OF ASSESSMENT</td></tr>
<tr><td>A</td><td colspan="4">Continuous Comprehensive Assessment (CCA) [25 marks]</td></tr>
<tr><td rowspan="6"></td><td colspan="2">Components</td><td colspan="2">Mark Distribution</td></tr>
<tr><td colspan="2">Module Test- I</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="2">Module Test- II</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="2">Module Test- III</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="2">Assignment/Seminar</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="2">Quiz/Viva voce</td><td colspan="2">5 Marks</td></tr>
<tr><td>B</td><td colspan="4">End Semester Evaluation (ESE)</td></tr>
<tr><td rowspan="7"></td><td colspan="4">Question Pattern
[Maximum Time 90 Minutes, Maximum Marks 50]</td></tr>
</table>

Module	Part A **1 Mark (MCQ)**	Part B **5 Marks**	Part C **10 Marks**	Total
I	7	2	1	**10**
II	7	2	1	**10**
III	6	2	0	**8**
Total no of questions	**20**	**6**	**2**	**28**

		Number of questions to be answered	**20**	**4**	**1**	**11**
		Total Marks	**20**	**20**	**10**	**50**

TEXT BOOKS:

1. Rosser, Mike, and Piotr Lis. *Basic mathematics for economists*. 3rd ed. Routledge, 2016.
2. Pemberton, Malcolm, and Nicholas Rau. *Mathematics for economists: an introductory textbook, 4th ed*. Manchester University Press, 2016.
3. N.D, Vohra. "Quantitative techniques in management." 3rd ed. Tata McGraw Hill New Delhi, 2007.
4. Ghosh, Ram Krishna, and Suranjan Saha. *Business Mathematics and Statistics, (Algebra, Geometry, and Business Statistics)*. New Central Book Agency, 2019.
5. Harmon, Mark. "Step-by-step optimization with Excel Solver." *Excel Master Series*, 2011.

SUGGESTED READINGS:

1. Mavron, Vassilis C., and Timothy N. Phillips. *Elements of Mathematics for Economics and Finance*. Classroom Companion: Economics. Springer Cham, 2023.
2. Newbold, Paul, et al. *Statistics for Business and Economics*. Pearson Education Limited, 2023

ADVANCED READINGS:

1. Manna, Asim Kumar. *Business Mathematics and Statistics*, McGraw Hill Education (India) Private Limited, 2018.
2. Bradley, Teresa. *Essential Mathematics for Economics and Business*, 4th edition, John Wiley & Sons, 2013.

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- Lab sessions using excel spreadsheet to perform matrix multiplication and to evaluate determinants.
- Lab sessions using excel spreadsheet to find the inverse of a matrix and to solve simultaneous equations
- Lab sessions using excel spreadsheet to solve linear programming problems (Refer Text 5)
- Practical sessions can be included

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<table>
<tr><td>Programme</td><td colspan="6">B Sc Mathematics</td></tr>
<tr><td>Course Name</td><td colspan="6">Document preparation using LaTeX</td></tr>
<tr><td>Type of Course</td><td colspan="6">Foundation Component - SEC</td></tr>
<tr><td>Course Code</td><td colspan="6">24SACMAT4SE201</td></tr>
<tr><td>Course Level</td><td colspan="6">200</td></tr>
<tr><td>Course Summary</td><td colspan="6">This course introduces students to the LaTeX typesetting system, a powerful tool for document preparation widely used in academia and industry. Building on basic LaTeX concepts, students will learn advanced techniques for creating professional-quality documents, including complex formatting, mathematical typesetting, and bibliography management.</td></tr>
<tr><td>Semester</td><td>4</td><td colspan="3">Credits</td><td>3</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Others</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="6">NIL</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
	Upon the successful completion of the course, the student will be able to		
1	Explain the fundamental principles of LaTeX typesetting	U,S	1,2
2	Apply advanced LaTeX formatting techniques to create professional-quality documents	A,S	1,2,3
3	Analyse and troubleshoot common errors in LaTeX documents	A,S	2,3,4

4	Create and customizebibliographies using BibTeX in LaTeX	C,S	1,2,3, 4
5	Demonstrate effective collaboration using LaTeX for group writing projects	A,S	3,4,9, 10
****Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)***			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	1.1	Preparing the input file	3	1
	1.2	Sentences and paragraphs, the document, sectioning, displayed material	3	1
	1.3	Running LaTeX	3	1,3
	1.3	Changing the type style	3	2
	1.4	Mathematical Formulas: common structures, Mathematical symbols, Arrays, Delimiters, Multiline formulas, Putting one thing above another, spacing and changing style in math mode.	2	2
		Text 1: Chapter 2 – Sections: 2.1 to 2.3; Chapter 3 – Sections: 3.1 & 3.3	**18**	
2	2.1	Defining commands and environments	6	3
	2.2	Figures and other floating bodies: Figures and Tables	6	2
		Text 1: Chapter 3 – Sections: 3.4 & 3.5.1	**12**	
3	3.1	Cross references	3	3

	3.2	Bibliography and citation	3	4
	3.3	Books	4	2
	3.4	Slides: Slides and overlays	4	5
		Text 1: Chapter 4 – Sections: 4.2 & 4.3; Chapter 5 – Sections: 5.1 & 5.2.1	**14**	
4	**Teacher Specific Contents** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)**		
	1. Interactive Instructions using ICT tools 2. Hands on Training		
Assessment Types	**MODE OF ASSESSMENT**		
	A	**Continuous Comprehensive Assessment (CCA) [25 marks]** Practical sessions or exams may be organised for each module and the CCA should be based on these hands-on experiences. One of the following activities should be done during the course. (i) Textbook Content Preparation: As part of CCA students must submit a document of at least 3 pages using a mathematics reference text of students or faculties choice. This document must be considered for CCA. (ii) Slide preparation: As part of CCA students must submit a presentation of at least 5 slides using beamer on some topic of teacher's choice. This presentation must be considered for CCA.	
		Components	**Mark Distribution**
		Module Test- I	**5** Marks
		Module Test- II	**5** Marks
		Module Test- III	**5** Marks
		Assignment/Seminar	**5** Marks
		Quiz/Viva voce	**5** Marks

	B	**End Semester Evaluation (ESE)**				
		Question Pattern [Maximum Time 90 Minutes, Maximum Marks 50]				
		Module	Part A	Part B	Part C	Total
			1 Mark (MCQ)	**5 Marks**	**10 Marks**	
		I	7	2	1	**10**
		II	7	2	1	**10**
		III	6	2	0	**8**
		Total no of questions	**20**	**6**	**2**	**28**
		Number of questions to be answered	**20**	**4**	**1**	**11**
		Total Marks	**20**	**20**	**10**	**50**

TEXT BOOK:

1. Lamport, Leslie. *LaTeX: A Document Preparation System*, Addison-Wesley, 2nd edition, 1994.

SUGGESTED READINGS:

1. Goossens, M., Mittelbach, F. F., Samarin, a. *The LaTeX Companion*, Addison-Wesley, 1993.
2. Krishnan, E. *LATEX Tutorials: A Primer*, Indian TEX Users Group, 2004.

Internship (CODE?)

Mathematics

Internship: Students can earn a maximum of 2 credits (4th Semester)

This internship programme enables students to gain practical experience and academic research skills, preparing them for careers in the mathematics field or further studies.

Duration: 60 Hours, between the fourth and fifth semesters.

Credit Allocation: 2 Credits

Objectives:

• Provide practical experience.
• Enhance skills in experimental techniques, data analysis, and scientific communication.
• Gain practical knowledge.
• Establish connections in the industry or research sector.
• Foster collaboration between academic institutions and industry/research organizations.

Evaluation Criteria: Total 50 marks

1. Internal Evaluation (15 marks):
   I. Feedback from the hosting organization (5 marks).
   II. Supervisor feedback (10 marks).

2. Final Evaluation (35 marks):
   I. Presentation (15 marks).
   II. Internship report (10 marks).
   III. Viva Voce (10 marks).

SEMESTER V

Semester 5

Course Code	Title of the Course	Type of the Course	Credit	Hours /Week	Hour Distribution /week			
					L	T	P	O
24SACMAT5DA301	A First Course in Complex Analysis	Discipline Specific Component - DSC A	4	5	3	0	1	0
24SACMAT5DA302	Limits and Convergence	Discipline Specific Component - DSC A	4	4	4	0	0	0
24SACMAT5DA303	Fundamentals of Groups and Rings	Discipline Specific Component - DSC A	4	5	3	0	1	0
24SACMAT5DE301	Differential Equations and Applications	Discipline Specific Elective - DSE	4	4	4	0	0	0
24SACMAT5DE302	Mathematical Musings Beyond Classroom	Discipline Specific Elective - DSE	4	4	4	0	0	0
24SACMAT5DE303*	Discrete and Fuzzy Mathematics	Discipline Specific Elective - DSE	4	4	4	0	0	0
24SACMAT5SE301**	Introduction to Python programming and document preparation using LaTeX	Foundation Component - SEC	3	3	1	0	1	0

L — Lecture, T — Tutorial, P — Practical/Practicum , O — Others

***Signature course by Department of Mathematics, St. Albert's College (Autonomous), Ernakulam**

****Signature course by Department of Mathematics, St. Albert's College (Autonomous), Ernakulam, Can be opted only by students who have taken Mathematics as Major**

Department of Mathematics St. Albert's College (Autonomous) Ernakulam

Programme	**B Sc Mathematics**
Course Name	**A First Course in Complex Analysis**
Type of Course	**Discipline Specific Component (DSC A)**
Course Code	**24SACMAT5DA301**
Course Level	**300**
Course Summary	The objective of this course is the introduction of basic concepts of complex analysis through a problem oriented approach. The course is designed for an understanding of elementary contour integrals, which serves as a powerful means to compute definite integrals and analyze the behaviour of complex functions. The Cauchy-Goursat theorem and Cauchy's integral formula which leads to the construction of Taylor series and Laurent series, the power series expansions that capture the intricate behaviour of analytic functions around specific points are analyzed through the course. The concepts of singularities, poles and resides along with their evaluation are introduced. Improper integrals, definite integrals with one or both limits of integration infinite, are being evaluated using the Cauchy's Residue Theorem.

Semester	**5**	**Credits**			**4**	
Course Details	**Learning Approach**	Lecture	Tutorial	Practical	Others	Total Hours/week
		3	0	1	0	**5**
Pre-requisites, if any	Complex numbers and operations, Regions of complex plane, Basic properties of functions of complex variables, Elementary functions of complex variables.					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
	Upon the successful completion of the course, the student will be able to		
1	Understand elementary contour integrals and their upper bounds and acquire a thorough knowledge of		

	contour integration methods.	U	1, 2
2	Demonstrate a comprehensive understanding of the complex plane's domains, singular points, and their classifications including isolated, removable and essential singularities.	U	1, 2, 3, 10
3	Apply Cauchy - Goursat theorem, Cauchy's integral formula, and Cauchy's residue theorem to calculate contour integrals, showcasing expertise in complex integration techniques.	A	1, 2 ,10
4	Elaborate on the consequences of Cauchy's integral formula, highlighting its significance in complex analysis and its applications to derivative calculations.	An	1, 2, 3
5	Effectively categorize poles and zeros of analytic functions, demonstrating a clear understanding of their roles in function behaviour and singularities.	An	1, 2
6	Construct series expansions for analytic functions using appropriate techniques, demonstrating proficiency in representing complex functions using power series.	C	1, 2, 10
7	Evaluate improper integrals using the residue theorem, showcasing the versatility of complex integration methods in solving problems involving improper integrals.	E	1, 2, 3, 10
****Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)***			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	CO No.	Hours
1		**Integration of Complex Functions**		
	1.1	Definite integrals of functions	1	
	1.2	Contours and contour integrals, Some examples, Upper bounds for moduli of contour integrals	1	

	1.3	Anti derivatives, Cauchy-Goursat Theorem (statement only), Some consequences of the extension	3	**22**
	1.4	Simply and multiply connected domains	2	
	1.5	Cauchy's integral formula, An extension of Cauchy's integral formula	3	
	1.6	Liouville's theorem and Fundamental theorem of algebra, Maximum modulus principle.	4	
		Problems (Practicum)	1, 3 , 4	
	Text 1: Sections: 38 to 41, 43, 44, 46, 48 to 54			
2		**Series of Complex Functions**		15
	2.1	Convergence of sequences and series	2	
	2.2	Taylor series, Proof of Taylor's Theorem, Examples	6	
	2.3	Laurent Series, Examples	6	
		Problems (Practicum)	2, 6	
	Text 1: Sections: 55 to 60 & 62			
3		**Residues and Poles**		**18**
	3.1	Isolated singular points, residues, Cauchy's Residue Theorem	2	
	3.2	Three types of isolated singular points, Residues at poles, examples.	2	
	3.3	Zeros of analytic functions, Zeros and poles	5	
		Problems (Practicum)	2, 5	

	Text 1: Sections: 68 to 70, 72 to 76			
4		**Evaluation of Improper Integrals**		20
	4.1	Evaluation of improper integrals, Example	7	
	4.2	Improper integrals from Fourier analysis. Jordan's Lemma (statement only)	7	
	4.3	Definite integrals involving sines and cosines	7	
		Problems (Practicum)	7	
	Text 1: Sections: 78 to 81 & 85			
5	**Teacher Specific Contents** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**			

Practicum
• Practicum is designed to provide supervised practical application of theoretical knowledge and skills. • Its purpose is to encourage creativity and develop Problem solving skills. • The practicum component is to be done in the classroom under the strict guidance of the teachers. • A minimum of 30 problems is to be solved, and a handwritten copy of the solutions should be kept in the department.

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)**		
	Lecture methods, Problem solving Methodologies, Activity based Tutorials/ Practical, Software based visualisation of concepts		
	MODE OF ASSESSMENT		
	A	**Continuous Comprehensive Assessment (CCA) [30 marks]**	
		Components	**Mark Distribution**

<table>
<tr><td rowspan="15">Assessment Types</td><td rowspan="6"></td><td colspan="3">Module Test- I</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test- II</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test- III</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test- IV</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Assignment/Seminar</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Quiz/Viva voce</td><td colspan="2">5 Marks</td></tr>
<tr><td>B</td><td colspan="5">End Semester Evaluation (ESE)</td></tr>
<tr><td rowspan="8"></td><td colspan="5">Question Pattern
[Maximum Time 2 Hours, Maximum Marks 70]</td></tr>
<tr><td>Module</td><td>Part A
1 Mark (MCQ)</td><td>Part B
5 Marks</td><td>Part C
10 Marks</td><td>Total</td></tr>
<tr><td>I</td><td>5</td><td>2</td><td>1</td><td>8</td></tr>
<tr><td>II</td><td>5</td><td>2</td><td>1</td><td>8</td></tr>
<tr><td>III</td><td>5</td><td>2</td><td>1</td><td>8</td></tr>
<tr><td>IV</td><td>5</td><td>2</td><td>1</td><td>8</td></tr>
<tr><td>Total no of questions</td><td>20</td><td>8</td><td>4</td><td>32</td></tr>
<tr><td>Number of questions to be answered</td><td>20</td><td>6</td><td>2</td><td>28</td></tr>
<tr><td></td><td></td><td>Total Marks</td><td>20</td><td>30</td><td>20</td><td>70</td></tr>
</table>

TEXT BOOK:

1. Brown, James Ward, Ruel V. Churchill. C*omplex variables and Applications* (8^{th} edition). McGraw-Hill, 2009.

SUGGESTED READINGS:

1. Saff, E. B., Snider A. D., Fundamentals of Complex Analysis with Applications to Engineering, Science and Mathematics. Pearson, 2002.

2. Ponnusamy, S., Herb Silverman. Complex variables with applications. Springer Science & Business Media, 2007.

3. Krantz, Steven G. Complex Variables: A physical approach with applications and MATLAB. CRC Press, 2007.

4. Kasana, Harvir Singh. Complex variables: theory and applications. PHI Learning Pvt. Ltd., 2005.

5. Zill, Dennis G., Patrick D. Shanahan. Complex analysis: A first course with applications. Jones & Bartlett Publishers, 2013.

6. Choudhary, B. The elements of complex analysis. New Age International, 1993.

7. Jeffrey, Alan. Complex analysis and applications. CRC Press, 2005

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Programme	**BSc Mathematics**					
Course Name	**Limits and Convergence**					
Type of Course	**Discipline Specific Component - DSC A**					
Course Code	**24SACMAT5DA302**					
Course Level	**300**					
Course Summary	This course offers a robust foundation in the analysis of sequences, series and the concept of limits of functions and thereby develops a comprehensive understanding of the mathematical structures crucial to calculus. Topics include limits of sequences, monotone sequences, subsequences, proper divergence, Cauchy sequences, and infinite series with a focus on convergence criteria, comparison tests, and special attention to tests like Root and Ratio, Raabe's, Alternating Series, Dirichlet and Abel test. The course also discusses the limit concepts of real functions. By course end, students possess a solid foundation for mathematical analysis					
Semester	5	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4	0	0	0	**4**
Pre-requisites, if any	Fundamental of real analysis.					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Analyse various convergence methods for sequences and determine their limits.	An	1,2,3
2	Investigate properties and analyse behaviour of		

	monotone sequences in mathematical contexts.	A, An	1,2,3,10
3	Examine the concept of sub sequences and demonstrate proficiency in analysing their properties within mathematical contexts.	An, A	1,2,3,10
4	Analysis and application of Cauchy sequences in mathematical contexts, demonstrating proficiency in understanding their convergence properties.	An, A	1,2,3,10
5	Comprehend fundamental concepts of infinite series and apply various tests for establishing their convergence or divergence.	U, A	1,2,3,10
6	Develop the fundamental concepts of absolute convergence and apply relevant tests to determine the convergence properties of series.	C, A	1,2,3,10
7	Apply alternative series tests specifically tailored for non-absolute convergence scenarios, demonstrating a nuanced understanding within mathematical contexts.	A	1,2,3,10
8	Develop the concept of limits of functions at specific points and adeptly apply theories to determine these limits and its properties.	U	1,2,3,10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	CO No.	Hours
1	1.1	Sequences and Their Limits	1	15
	1.2	Limit Theorems	1	
	1.3	Monotone Sequences	2	
	Text 1: Chapter 3 - Sections: 3.1, 3.2 (Theorems 3.2.3 and 3.2.11 – statements only), 3.3 (up to 3.3.3)			
2	2.1	Subsequences and the Bolzano-Weierstrass Theorem.	3	15
	2.2	The Cauchy Criterion	4	

	2.3	Properly Divergent Sequences	5	
	Text 1: Chapter 3 - Sections: 3.4 (Theorems 3.4.11 and 3.4.12 – statements only), 3.5 (up to 3.5.8, Theorem 3.5.8 – statement only) & 3.6			
3	3.1	Infinite Series- n^{th} term test, comparison test, limit comparison test.	5	15
	3.2	Absolute Convergence, Grouping and rearrangements of series	6	
	3.3	Tests for Absolute Convergence: Limit comparison Test II, The Root and Ratio Test (Concepts and Problems only)	6	
	3.4	The Raabe's Test (Concepts and Problems only)	6	
	3.5	Test for Nonabsolute Convergence: Alternating Series Test, The Dirichlet and Abel test. (Concepts and Problems only)	7	
	Text 1: Chapter 3 - Sections: 3.7; Chapter 9 - Sections: 9.1 (Theorem 9.1.5 – statement only), 9.2.1 to 9.2.5, 9.2.8 to 9.2.10 & 9.3 (Concepts, statements of the theorems and problems only from sections 9.2 and 9.3)			
4	4.1	Limits of Functions	8	15
	4.2	Limit Theorems	8	
	4.3	Some Extensions of the Limit Concept	8	
	Text 1: Chapter 4 - Sections: 4.1 (Theorems 4.1.6 and 4.1.9 – statements only), 4.2 (Theorems 4.2.4 and 4.2.9 – statements only), 4.3 (Concepts, statements of the theorems and problems only)			
5	**Teacher Specific Contents** (This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned) **This content will be evaluated internally**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)**
	Lecture, Tutorial and Activity oriented

<table>
<tr><td rowspan="20">Assessment Types</td><td colspan="6">MODE OF ASSESSMENT</td></tr>
<tr><td>A</td><td colspan="5">Continuous Comprehensive Assessment (CCA) [30 marks]</td></tr>
<tr><td rowspan="7"></td><td colspan="3">Components</td><td colspan="2">Mark Distribution</td></tr>
<tr><td colspan="3">Module Test- I</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test- II</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test- III</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test- IV</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Assignment/Seminar</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Quiz/Viva voce</td><td colspan="2">5 Marks</td></tr>
<tr><td>B</td><td colspan="5">End Semester Evaluation (ESE)</td></tr>
<tr><td rowspan="10"></td><td colspan="5">Question Pattern
[Maximum Time 2 Hours, Maximum Marks 70]</td></tr>
<tr><td rowspan="2">Module</td><td>Part A</td><td>Part B</td><td>Part C</td><td rowspan="2">Total</td></tr>
<tr><td>1 Mark (MCQ)</td><td>5 Marks</td><td>10 Marks</td></tr>
<tr><td>I</td><td>5</td><td>2</td><td>1</td><td>8</td></tr>
<tr><td>II</td><td>5</td><td>2</td><td>1</td><td>8</td></tr>
<tr><td>III</td><td>5</td><td>2</td><td>1</td><td>8</td></tr>
<tr><td>IV</td><td>5</td><td>2</td><td>1</td><td>8</td></tr>
<tr><td>Total no of questions</td><td>20</td><td>8</td><td>4</td><td>32</td></tr>
<tr><td>Number of questions to be answered</td><td>20</td><td>6</td><td>2</td><td>28</td></tr>
<tr><td>Total Marks</td><td>20</td><td>30</td><td>20</td><td>70</td></tr>
</table>

TEXTBOOK:

1. Robert G Bartle., Donald R Sherbert. *Introduction to Real Analysis (4th Edition)*, Wiley Internationals, 2000

SUGGESTED READINGS

- Denlinger, Charles. *Elements of real analysis*. Jones & Bartlett Learning, 2011.
- Howie, John M. *Real analysis*. Springer Science & Business Media, 2006.

- Abbott, Stephen. *Understanding analysis*. springer publication, 2015.
- Ghorpade, Sudhir R., Balmohan Vishnu Limaye. *A course in calculus and real analysis*. New York: Springer, 2006.
- Kumar, Ajit, Kumaresan, S. *A basic course in real analysis*. CRC press, 2014.

ADVANCED READINGS:

1. Gelbaum, Bernard R., and John MH Olmsted. *Counterexamples in analysis*. Courier Corporation, 2003.
2. Rudin, Walter. *Principles of mathematical analysis*. Vol. 3. New York: McGraw-hill, 1976.
3. Apostol, Tom M. *Mathematical analysis*. 1974.
4. Royden, Halsey Lawrence, and Patrick Fitzpatrick. *Real analysis*. Vol. 2. New York: Macmillan, 1968.

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- The $K(\varepsilon)$ Game.
- Corollary 3.5.10 and approximate solutions of equations.
- Calculation of Square roots.
- Euler Number.
- Fibonacci fractions and golden ratio.
- The integral test.
- Proof of theorems 3.2.3 and 3.2.11.
- Proof of theorems 3.4.11, 3.4.12 and 3.5.8.
- Proof of theorem 9.1.5, proof of all theorems of Section 9.2 and Section 9.3.
- Proof of theorems 4.1.6, 4.1.9, 4.2.4 and 4.2.9.
- Proof of all theorems of Section 4.3.

Department of Mathematics
St. Albert's College (Autonomous) Ernakulam

<table>
<tr><td>Programme</td><td colspan="6">B Sc Mathematics</td></tr>
<tr><td>Course Name</td><td colspan="6">Fundamentals of Groups and Rings</td></tr>
<tr><td>Type of Course</td><td colspan="6">Discipline Specific Component (DSC A)</td></tr>
<tr><td>Course Code</td><td colspan="6">24SACMAT5DA303</td></tr>
<tr><td>Course Level</td><td colspan="6">300</td></tr>
<tr><td>Course Summary</td><td colspan="6">The objective of the course is to introduce group and ring theory for a beginner.
The basic algebraic structure group, its subgroups, cyclic groups, permutations, cosets, homomorphisms, and normal subgroups are covered in the first three modules.
Rings and Fields are introduced in the fourth module.</td></tr>
<tr><td>Semester</td><td>5</td><td colspan="3">Credits</td><td>4</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Others</td></tr>
<tr><td>3</td><td>0</td><td>1</td><td>0</td><td>5</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="6">Basic Set Theory and Mathematical Operations</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
	Upon the successful completion of the course, the student will be able to		
1	Comprehend binary operations, isomorphic structures, groups, and subgroups.	U	1,2,3,4,5

2	Analyse cyclic groups and permutation groups and apply these concepts to solve problems in group theory.	A	1,2,3,4,5
3	Use cosets to prove Lagrange's theorem, analyse homomorphisms, and understand Cayley's Theorem.	A	1,2,3,4,5
4	Analyse rings, fields, and integral domains, and thus become adept in algebraic structures.	A	1,2,3,4,5
5	Apply the ideas of Groups and Permutation in Practical Situations.	A	1,2,3,4,5
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	CO No.	Hours
1	1.1	Binary Operations – Definitions and Examples	1	**20**
	1.2	Groups – Definition, Examples	1	
	1.3	Groups - Elementary Properties	1	
	1.4	Group Isomorphism, Group Tables and Examples of Abelian Groups	1	
		Problems (Practicum)	1	
	Text 1: Chapter 1 – Sections: 1.1 to 1.30; Chapter 2 – Sections: 2.1 to 2.23; Chapter 3 – Sections: 3.1 to 3.5			
2	2.1	Examples of non-abelian groups and Permutation Group	2	**20**
	2.2	Symmetric Groups and Disjoint Cycles	2	
	2.3	Subgroups, Cyclic Groups and Cyclic Subgroups	2	

		Problems (Practicum)	2	
	Text 1: Chapter 4 – Sections: 4.1 to 4.16; Chapter 5 – Sections: 5.1 to 5.26; Chapter 6 – Sections: 6.1 to 6.21			
3	3.1	Generating Sets	**3**	**20**
	3.2	Group Homomorphism and Group of Permutation	3	
	3.3	Kernel, Cayley's Theorem, Even and Odd Permutation	3	
	3.4	Cosets and Theorem of Lagrange	3	
		Problems (Practicum)		
	Text 1: Chapter 7 – Sections: 7.1 to 7.6; Chapter 8 – Sections: 8.1 to 8.25; Chapter 10 – Sections: 10.1 to 10.20			
4	4.1	Rings and Fields	4	**15**
	4.2	Integral Domain, Characteristic of a Ring.	4	
	4.3	Field of Quotients of an Integral Domain (Statement only)	4	
		Problems (Practicum)	4	
	Text 1: Chapter 22 – Sections: 22.1 to 22.18; Chapter 23 – Sections: 23.1 to 23.14; Chapter 26 Examples: 26.1 & 26.6 (Theorem 26.6-Statement only)			
5	**Teacher Specific Contents** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)*			

	This content will be evaluated internally

Practicum
• Practicum is designed to provide supervised practical application of theoretical knowledge and skills. • Its purpose is to encourage creativity and develop Problem solving skills. • The practicum component is to be done in the classroom under the strict guidance of the teachers. • A minimum of 30 problems is to be solved, and a handwritten copy of the solutions should be kept in the department.

<table>
<tr><td rowspan="2">Teaching and Learning Approach</td><td colspan="6">Classroom Procedure (Mode of transaction)</td></tr>
<tr><td colspan="6">Lectures, Tutorials, Interactive Sessions, Blended Learning</td></tr>
<tr><td rowspan="16">Assessment Types</td><td colspan="6">MODE OF ASSESSMENT</td></tr>
<tr><td>A</td><td colspan="5">Continuous Comprehensive Assessment (CCA) [30 marks]</td></tr>
<tr><td rowspan="7"></td><td colspan="3">Components</td><td colspan="2">Mark Distribution</td></tr>
<tr><td colspan="3">Module Test- I</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test- II</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test- III</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test- IV</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Assignment/Seminar</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Quiz/Viva voce</td><td colspan="2">5 Marks</td></tr>
<tr><td>B</td><td colspan="5">End Semester Evaluation (ESE)</td></tr>
<tr><td rowspan="5"></td><td colspan="5">Question Pattern
[Maximum Time 2 Hours, Maximum Marks 70]</td></tr>
<tr><td rowspan="2">Module</td><td>Part A</td><td>Part B</td><td>Part C</td><td rowspan="2">Total</td></tr>
<tr><td>1 Mark (MCQ)</td><td>5 Marks</td><td>10 Marks</td></tr>
<tr><td>I</td><td>5</td><td>2</td><td>1</td><td>8</td></tr>
</table>

		II	5	2	1	**8**
		III	5	2	1	**8**
		IV	5	2	1	**8**
		Total no of questions	**20**	**8**	**4**	**32**
		Number of questions to be answered	**20**	**6**	**2**	**28**
		Total Marks	**20**	**30**	**20**	**70**

TEXT BOOKS:

1. Fraleigh, John B.;. Brand, Neal E, *A First Course in Abstract Algebra* 8th ed, Pearson Education 2021
2. Gallian, Joseph A. *Contemporary Abstract Algebra*, 10th edition, Cengage, 2021.

SUGGESTED READINGS:

1. Dummit, David S., and Richard M. Foote. *Abstract Algebra. 3rd ed.* Wiley, 2003.
2. Artin, M. *Algebra. 2nd ed., Pearson Education 2017*
3. Herstein, I. N. *Topics in Algebra*, 2nd *Edition, John Wiley and sons, 2010*
4. Musili, C. *Rings and Modules 2nd* revised *Edition, Narosa 1997*

ADVANCED READINGS:

1. Hungerford, Thomas.W., Algebra, 4th Print 2003 Edition.
2. Lang, Serge, Algebra, 4th Print 2005 Edition

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- Realisation of the group D4 as symmetries of a square. (Chapter 1 of Text 2)
- Rotations of a Regular Tetrahedron and Application in Chemistry (Chapter 5 – Example 10 of Text 2)
- Group Theory Puzzle – Rubik's Cube (Chapter 5 of Text 2)

Department of Mathematics
St. Albert's College (Autonomous)
Ernakulam

Programme	**B Sc Mathematics**					
Course Name	**Differential Equations and Applications**					
Type of Course	**Discipline Specific Elective (DSE)**					
Course Code	**24SACMAT5DE301**					
Course Level	**300**					
Course Summary	The course covers basics of ordinary and partial differential equations, various methods for solving them and also include some practical applications.					
Semester	5	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4	0	0	0	4
Pre-requisites, if any	Basic knowledge of functions, differentiation and integration. Basic understanding of ordinary and partial differential equations, including degree and order. Knowledge in constructing ordinary differential equations. Basic understanding of the concept of solutions.					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
	Upon the successful completion of the course, the student will be able to		
1	Develop the idea of solving first order Differential Equations	A	1, 2
2	Apply first order Differential Equations to practical situations and solve	A, An	1, 2, 3
3	Solve higher order Differential Equations	A	1, 2

4	Develop the concept of Partial Differential Equations and solve	U, A	1, 2
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	1.1	Exact Differential Equations and Integrating Factors	4	1
	1.2	Separable Equations and Equations Reducible to this form	3	1
	1.3	Linear Equations	4	1
	1.4	Bernoulli Equations	4	1
		Text 1: Chapter 2 – Sections: 2.1 (Theorem 2.1 statement only), 2.2 & 2.3	**15**	
2	2.1	Finding Integrating Factors	3	1
	2.2	A Special Transformation	3	1
	2.3	Orthogonal Trajectories	3	2
	2.4	Geometric Applications	1	2
		Text 1: Chapter 2 – Sections: 2.4 A & 2.4 B; Chapter 3 – section: 3.1 A, Text 2: Chapter 12 - section 12.2	**10**	
3	3.1	Definition and Basic Existence Theorem	1	3
	3.2	The Homogeneous Equation	3	3

	3.3	Reduction of Order	2	3
	3.4	The Non-Homogeneous Equation	4	3
	3.5	The Homogeneous Linear Equation with Constant Coefficients	5	3
	3.6	The Method of Undetermined Coefficients	5	3
	3.7	Variation of Parameters	5	3
		Text 1: Chapter 4 – Sections: 4.1 A, 4.1 B, 4.1 C, 4.1 D, 4.2, 4.3, 4.4	**25**	
4	4.1	Methods of solution of $\frac{dx}{P} = \frac{dy}{Q} = \frac{dz}{R}$	4	4
	4.2	Partial Differential Equations, Origin of First Order Partial Differential Equations	3	4
	4.3	First Order Linear Partial Differential Equations	3	4
		Text 3: Chapter 1 – Section: 3; Chapter 2 - sections-1,2,4 (Theorem 2 & 3 statement only)	**10**	
5	**Teacher Specific Contents** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)**		
	1. Direct Instruction: Explicit Teaching, Lecture. 2. Interactive Instruction: Active Co-operative Learning, Group Assignments		
	MODE OF ASSESSMENT		
	A	**Continuous Comprehensive Assessment (CCA) [30 marks]**	
		Components	**Mark Distribution**
		Module Test- I	**5** Marks

Assessment Types		Module Test- II			**5** Marks		
		Module Test- III			**5** Marks		
		Module Test- IV			**5** Marks		
		Assignment/Seminar			**5** Marks		
		Quiz/Viva voce			**5** Marks		
	B	**End Semester Evaluation (ESE)**					
		Question Pattern [Maximum Time 2 Hours, Maximum Marks 70]					
		Module	Part A **1 Mark (MCQ)**	Part B **5 Marks**	Part C **10 Marks**	Total	
		I	5	2	1	**8**	
		II	5	2	1	**8**	
		III	5	2	1	**8**	
		IV	5	2	1	**8**	
		Total no of questions	**20**	**8**	**4**	**32**	
		Number of questions to be answered	**20**	**6**	**2**	**28**	
		Total Marks	**20**	**30**	**20**	**70**	

TEXT BOOKS:

1. Ross, Shepley L. *Differential Equations*. 3^{rd} ed. Wiley. 2013.
2. Grewal, B. S.. *Higher Engineering Mathematics*. 42^{nd} ed. Khanna Publications. 2012
3. Sneddon, Ian N.. *Elements of Partial Differential Equations*. 1^{st} ed. McGraw-Hill. 1957

SUGGESTED READINGS:

1. Simmons, George F., Steven G Krantz.. *Differential Equations -Theory, Technique, and Practice*. 1^{st} ed. McGraw-Hill (Walter Rudin Student Series). 2007
2. Amaranath,T.. *An Elementary Course in Partial Differential Equations*, 2^{nd} ed. Jones and Bartlett. 20 0 9

ADVANCED READING:

1. Simmons, George F.. *Differential Equations with Applications andHistorical Notes.* 3rd ed. CRC Press, Taylor & Francis. 2016

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- Applications of Ordinary Differential Equations of First Order in SimpleElectric Circuits
- Rate of Decay of Radioactive Materials
- Chemical Reactions and Solutions

(Text 2: Chapter 12-Section 12.5, 12.8, 12.9)

Department of Mathematics
St. Albert's College (Autonomous)
Ernakulam

Programme	**B.Sc. Mathematics**					
Course Name	**Mathematical Musings beyond Classroom**					
Type of Course	**Discipline Specific Elective – DSE**					
Course Code	**24SACMAT5DE302**					
Course Level	**300**					
Course Summary	Step beyond the confines of classrooms, where mathematics transforms from a mere subject into a gateway, leading you to infinite possibilities and allowing you to revel in the beauty of mathematics.					
Semester	**5**	**Credits**			**4**	
Course Details	**Learning Approach**	Lecture	Tutorial	Practicum	Others	Total Hours/week
		4	0	0	0	**4**
Pre-requisites, if any						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
	Upon the successful completion of the course, the student will be able to		
1	Acquire a solid understanding of fundamental mathematical concepts including algebra, geometry, calculus, and probability.	K	3
2	Understand the evolution of mathematical thought and its role in shaping scientific and technological	U	6

	advancements.		
3	Develop the ability to apply mathematical principles to solve real-world problems.	A	1,2
4	Explore the intersection of mathematics with other fields, as portrayed in films.	An	3,5,7
5	Discuss ethical considerations in mathematical research and applications. Encourage students to critically reflect on their own learning and understanding of mathematical concepts.	E	4,6,8,9
6	Demonstrate how mathematics intersects with various disciplines, including science, arts, and humanities.	C	3,10
7	Encourage independent research on specific mathematical topics, historical developments, or philosophical questions.	I	6,10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	CO No.	Hours
1		**Exploring Enchanting Texts**		15
	1.1	An Introduction to Exploring Enchanting Texts of Mathematics.	1	
	1.2	Text Book 1 Chapter- 1: Nothing Doing [The Origin of Zero], Chapter- 3: Nothing Ventured [Zero Goes East]	2,6,7	
	1.3	Text Book 2 Part Five: Data (Chapter- 22: The New Normal, Chapter- 23: Chances Are, Chapter- 24: Untangling the Web)	1, 2,3,6	
	1.4	Text Book 3 Chapter- 3: Einstein vs. Dostoyevsky	2, 5	

	Text 1, Text 2, and Text 3			
2		**Math Meets the Silver Screen**		
	2.1	Introduction to Mathematics on the Silver Screen.	1	**12**
	2.2	The film *A Beautiful Mind* (2001) directed by Ron Howard.	4,5	
	2.3	The film *The Imitation Game* (2014) directed by Morten Tyldum.	2, 4,7	
	2.4	The film *The Man Who Knew Infinity* (2015) directed by Matthew Brown.	2,3,4	
	2.5	The film *Hidden Figures* (2016) directed by Theodore Melfi.	2,4,5	
3		**Mathematical Prelude: Kerala's Historical Journey**		
	3.1	The Actors, The Social Background.	1,2,7	
	3.2	The Motivation and Method, The Madhava- Gregory Series for the Inverse Tangent, The Madhava- Newton Power Series for the Sine and Cosine.	2,7	**15**
	3.3	Transmission of Kerala Mathematics: Establishing Transmissions: A Digression, The Case for Transmission: Applying the Neugebauer Criteria.	2,7	
	3.4	The Case for Transmission: Applying the Legal Standard of Motivation and Opportunity, A Conjecture on the Mode of Acquisition of Manuscripts by the Jesuits.	2,5	
	Text 4: Chapter- 10: A Passage to Infinity: The Kerala Episode.			

4		**Unveiling the Philosophy of Mathematics**		**18**
	4.1	Text Book 5 Part One, Chapter- 5: Five Classical Puzzles.	2,7	
	4.2	Text Book 6 Chapter- 1: Mathematics and Its Philosophy (Sections 1.1 &1.2).	2,5,7	
	4.3	Text Book 6 Chapter- 2: The Limits of Mathematics.	2,5,7	
	Text 5 and Text 6			
5	**Teacher Specific Contents** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**			

Practicum
• Practicum is designed to provide supervised practical application of theoretical knowledge and skills. • Its purpose is to encourage creativity and develop Problem solving skills. • The practicum component is to be done in the classroom under the strict guidance of the teachers. • A minimum of 30 problems is to be solved, and a handwritten copy of the solutions should be kept in the department.

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)**		
	Direct Instruction, Brain Storming Approach, Interactive Instruction, Watching Movies, Group Discussion, and Presentation by Individual Student/ Group Representatives.		
	MODE OF ASSESSMENT		
	A	**Continuous Comprehensive Assessment (CCA) [30 marks]**	
		Components	**Mark Distribution**

<table>
<tr><td rowspan="16">Assessment Types</td><td rowspan="6"></td><td colspan="4">Module Test- I</td><td>5 Marks</td></tr>
<tr><td colspan="4">Module Test- II</td><td>5 Marks</td></tr>
<tr><td colspan="4">Module Test- III</td><td>5 Marks</td></tr>
<tr><td colspan="4">Module Test- IV</td><td>5 Marks</td></tr>
<tr><td colspan="4">Assignment/Seminar</td><td>5 Marks</td></tr>
<tr><td colspan="4">Quiz/Viva voce</td><td>5 Marks</td></tr>
<tr><td>B</td><td colspan="5">End Semester Evaluation (ESE)</td></tr>
<tr><td rowspan="9"></td><td colspan="5">Question Pattern
[Maximum Time 2 Hours, Maximum Marks 70]</td></tr>
<tr><td rowspan="2">Module</td><td>Part A</td><td>Part B</td><td>Part C</td><td rowspan="2">Total</td></tr>
<tr><td>1 Mark (MCQ)</td><td>5 Marks</td><td>10 Marks</td></tr>
<tr><td>I</td><td>5</td><td>2</td><td>1</td><td>8</td></tr>
<tr><td>II</td><td>5</td><td>2</td><td>1</td><td>8</td></tr>
<tr><td>III</td><td>5</td><td>2</td><td>1</td><td>8</td></tr>
<tr><td>IV</td><td>5</td><td>2</td><td>1</td><td>8</td></tr>
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<tr><td>Number of questions to be answered</td><td>20</td><td>6</td><td>2</td><td>28</td></tr>
<tr><td></td><td></td><td>Total Marks</td><td>20</td><td>30</td><td>20</td><td>70</td></tr>
</table>

TEXT BOOKS:

1. Seife, Charles. *Zero*: *The Biography of a Dangerous Idea*. United States, Penguin Publishing Group, 2000.
2. Strogatz, Steven Henry. *The Joy of X: A Guided Tour of Math, from One to Infinity*. United States, Houghton Mifflin Harcourt, 2012.
3. Hoffman, Paul. *The Man Who Loved Only Numbers*: *The Story of Paul Erdos and the Search for Mathematical Truth*. London, Fourth Estate, 1999.
4. George Gheverghese Joseph. *The Crest of the Peacock - Non-European Roots of Mathematics* (3rd Edition). Princeton University Press, Princeton & Oxford, 2011.
5. Hersh, Reuben. *What is Mathematics, Really?*. United Kingdom, Oxford University Press, 1997.

6. Colyvan, Mark. *An Introduction to the Philosophy of Mathematics*. United Kingdom, Cambridge University Press, 2012.

SUGGESTED READINGS:

1. Singh, Simon. *Fermat's Last Theorem*. United Kingdom, Harper Collins Publishers, 2012.
2. Oakley, Barbara A. *A Mind for Numbers: How to Excel at Math and Science (Even If You Flunked Algebra)*. United Kingdom, Penguin Publishing Group, 2014.

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- Reading of the related books:
    - Nasar, Sylvia. *A Beautiful Mind*. United Kingdom, Faber &Faber, 2012.
    - Hodges, Andrew, and Hofstadter, Douglas. *Alan Turing: The Enigma: The Book That Inspired the Film The Imitation Game* -Updated Edition. United Kingdom, Princeton University Press, 2014.
    - Kanigel, Robert. *The Man Who Knew Infinity: A Life of the Genius Ramanujan*. India, Washington Square Press, 2016.
    - Shetterly, Margot Lee. *Hidden Figures*. United States, Harper Collins, 2018.
- Visit a place of mathematical importance.
- Book Reviews/Film Reviews/Group Discussions/Debates.

Department of Mathematics St. Albert's College (Autonomous) Ernakulam

Programme	**B. Sc Mathematics**					
Course Name	**Discrete and Fuzzy Mathematics**					
Type of Course	**Discipline Specific Elective - DSE**					
Course Code	**24SACMAT5DE303**					
Course Level	**300**					
Course Summary	This course provides a basic knowledge about discrete Mathematics, Fuzzy Sets and Fuzzy graphs. The first part giving the brief knowledge about Statements and notation, Connectives, Normal forms, Theory of Inference for the statement calculus. Second part is completely figures out the concepts of Predicate Calculus, Inference theory of the predicate calculus, Lattices as Partially ordered set. The third and final parts provide the basic knowledge about Fuzzy sets and fuzzy graphs with basic results and illustrations.					
Semester	**5**	Credits		**4**		Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4	0	0	0	**4**
Pre-requisites, if any	Basic Knowledge needed in logic gates and Graph theory					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Illustrate and use the statements, notations, and connectives. Construct truth table and utilize conditional and biconditional statements. Understand the theory of inference	U	1
2	Analyse and explain Predicate calculus. Construct lattices and special lattices.	An	2
3	To demonstrate a comprehensive understanding of fuzzy	U	3

	set theory		
4	To handle the real-life situations using fuzzy Graphs	I	4
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course Description	Hrs	CO No.
1	1.1	Statements and notation	2	1
	1.2	Connectives	8	1
	1.3	Normal forms	6	1
	1.4	The theory of Inference for the statement calculus	4	1
	(Text 1, Chapter 1: 1.1, 1.2, 1.3, 1.4)		**20**	
2	2.1	The Predicate Calculus	5	2
	2.2	Predicate formulas	5	2
	2.3	Inference theory of the predicate calculus	4	2
	2.4	Theory of inference for the predicate calculus	2	2
	2.5	Lattices as Partially ordered set	2	2
	(Text 1: Chapter 1: 1.5 and 1.6, Chapter 4: 4.1)		**18**	
3	3.1	Crisp Sets: An over view	3	3

	3.2	Fuzzy Sets: Basic Types & Concepts	5	3
	3.3	Alpha Cuts	4	3
	3.4	Representation of Fuzzy Sets & Extension Principle	5	3
	3.5	Activity: Theorem 2.8, 2.8, 2.10	2	3
	(Text 2, Chapter 1: 1.1, 1.2, 1.3, 1.4, Chapter 2: 2.1, 2.2)		**19**	
4	4.1	Basic Graph theory (Definition, Subgraph, connectivity, cut vertex, cut edge)	4	4
	4.2	Fuzzy graph with Example	3	4
	4.3	Different types of Fuzzy Graphs with examples	3	4
	4.4	Fuzzy Bridge and Fuzzy Cut vertex with examples	2	4
	4.5	Complete Fuzzy Graphs with Examples	1	4
	4.6	Activity: Discussion on real life situations using Fuzzy Graphs	2	4
	(Text 3, Chapter 2: 2.1, 2.2)		**15**	
5	**Teacher Specific Contents** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)**		
	Direct Instruction, Brainstorming Lecture, Explicit Teaching, Active Co-operative Learning,		
	MODE OF ASSESSMENT		
	A	**Continuous Comprehensive Assessment (CCA) [30 marks]**	
		Components	**Mark Distribution**

Assessment Types		Module Test- I			**5** Marks		
		Module Test- II			**5** Marks		
		Module Test- III			**5** Marks		
		Module Test- IV			**5** Marks		
		Assignment/Seminar			**5** Marks		
		Quiz/Viva voce			**5** Marks		
	B	**End Semester Evaluation (ESE)**					
		Question Pattern [Maximum Time 2 Hours, Maximum Marks 70]					
		Module	Part A **1 Mark (MCQ)**	Part B **5 Marks**	Part C **10 Marks**	Total	
		I	5	2	1	**8**	
		II	5	2	1	**8**	
		III	5	2	1	**8**	
		IV	5	2	1	**8**	
		Total no of questions	**20**	**8**	**4**	**32**	
		Number of questions to be answered	**20**	**6**	**2**	**28**	
		Total Marks	**20**	**30**	**20**	**70**	

TEXTBOOKS:

1. J. P. Tremblay and Manohar – Discrete Mathematical Structures with Applications to Computer science (Tata McGraw Hill, New Delhi)
2. George J Klir & Bo Yuan, Fuzzy Sets and Fuzzy Logic Theory and Applications, Prentice Hall of India Private Limited, New Delhi, 2000.
3. Sunil Mathew, John M Moderson, Devendar S. Malik, Fuzzy Graph Theory, Springer, 2018.

SUGGESTED READINGS:

1. G. Balaji – Discrete Mathematics (Balaji Publishers: Chennai 2013)
2. Garett Birkhoff – Lattice Theory (American Mathematical Society, 2009)
3. T. Veerarajan - Discrete Mathematics (Tata McGraw Hill- 2009)
4. Rosen, Kenneth. H, Discrete Mathematics and Its Applications, 7th Edition, MaGraw Hill Publishing, New Delhi, 2013)
5. John N. Moderson, Sunil Mathew, Advanced Topics in Fuzzy Graph Theory, Springer 2019.

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- Figures out the Concepts of connectivity and Normal forms
- Study the predicate calculus and inference theory.
- Introducing Fuzzy sets and extending it into alpha cuts.
- Introducing Fuzzy graph and providing some results on it.

Department of Mathematics St. Albert's College (Autonomous) Ernakulam

Programme	**B.Sc Mathematics**					
Course Name	**Introduction to Python programming and document preparation using LaTeX**					
Type of Course	**Foundation Component - SEC**					
Course Code	**24SACMAT5SE301**					
Course Level	**300**					
Course Summary	This course provides the skills to utilize Python for Mathematical Computations, modeling and problem solving through a hands on approach students. The students will also be equipped with document preparation skills using LaTeX.					
Semester	5	Credits			3	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		1	0	1	0	3
Pre requisites, if any	Fundamental knowledge in Matrices.					

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
	Upon the successful completion of the course, the student will be able to		

1	Understand the basics of Python programming language.	U,S	1,2
2	Apply strings and lists, tuples, and packages for computation.	A,S	1,2,3,4
3	Employ NumPy for efficient numerical and mathematical operations in Python.	A,S	1,2,3,10
4	Apply advanced LaTeX formatting techniques to create professional-quality documents.	A,C,S	1,2,3,4,9,10
****Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)***			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	1.1	Getting started with Python	1	1
	1.2	Variables and Data Types	1	1
	1.3	Operators and their Precedence	1	1
	1.4	Python String	1	1
	1.5	Python Lists	1	1
	1.6	Mutable and Immutable Types	1	1
	1.7	Input from the Keyboard	1	1
	1.8	Iteration: while and for loops	1	1
	1.9	Conditional Execution: if, elif and else	1	1
	1.10	Modify loops : break and continue	1	1

		Sections 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, 2.9, 2.10 and 2.12 of Text 1	**10 hrs**	
2	2.1	Functions	2	2
	2.2	More on Strings and Lists	2	2
	2.3	Python Modules and Packages	2	2
		Sections 2.13, 2.14 and 2.15 of Text 1	**6**	
3	3.1	The NumPy Module - CreatingArrays and Matrices	2	3
	3.2	Copying	2	3
	3.3	Arithmetic Operations	2	3
	3.4	cross product	2	3
	3.5	dot product	2	3
	3.6	Saving and Restoring	2	3
	3.7	Matrix inversion .	3	3
	3.8	Vectorized Functions	3	3
		Sections 3.1,3.2 and 3.3 of Text 1	**18**	
4	4.1	Preparing the input file	2	4

	4.2	Sentences and paragraphs, the document, sectioning, displayed material	2	4
	4.3	Running LaTeX	2	4
	4.4	Changing the type style	2	4
	4.5	Mathematical Formulas: common structures, Mathematical symbols, Arrays, Delimiters, Multiline formulas, Putting one thing above another, spacing and changing style in math mode.	2	4
	4.6	Defining commands and environments	2	4
	4.7	Figures and other floating bodies: Figures andTables	2	4
	4.8	Cross References	2	4
	4.9	Bibliography and citation	2	4
	4.10	Books	1	4
	4.11	Slides: Slides and overlays	1	4
		Sections 2.1, 2.2, 2.3, 3.1, 3.3, 3.4, 3.5, 4.2,4.3, 5.1 and 5.2.1 of Text 2	**20**	

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)**
	Interactive instructions using ICT tools Hands on training

<table>
<tr><td rowspan="16">Assessment Types</td><td colspan="5">MODE OF ASSESSMENT</td></tr>
<tr><td colspan="5">Continuous Comprehensive Assessment (CCA) [30 marks]</td></tr>
<tr><td colspan="3">Components</td><td colspan="2">Mark Distribution</td></tr>
<tr><td colspan="3">Module Test- I</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test- II</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test- III</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Assignment/Seminar</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Quiz/Viva voce</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="5">End Semester Evaluation (ESE)</td></tr>
<tr><td colspan="5">Question Pattern
[Maximum Time 90 Minutes, Maximum Marks 50]</td></tr>
<tr><td>Module</td><td>Part A
1 Mark (MCQ)</td><td>Part B
5 Marks</td><td>Part C
10 Marks</td><td>Total</td></tr>
<tr><td>I</td><td>7</td><td>2</td><td>1</td><td>10</td></tr>
<tr><td>II</td><td>7</td><td>2</td><td>1</td><td>10</td></tr>
<tr><td>III</td><td>6</td><td>2</td><td>0</td><td>8</td></tr>
<tr><td>Total no of questions</td><td>20</td><td>6</td><td>2</td><td>28</td></tr>
<tr><td>Number of questions to be answered</td><td>20</td><td>4</td><td>1</td><td>11</td></tr>
<tr><td></td><td>Total Marks</td><td>20</td><td>20</td><td>10</td><td>50</td></tr>
</table>

TEXTBOOKS

Text 1: Python for Education by Ajith Kumar B P (https://www.iuac.res.in/phoenix/python4schools/Python-for- Education.pdf?shem=ssc)

Text 2: Lamport, Leslie, LaTeX: A Document Preparation System, Addison-Wesley, 2nd edition (1994).

SUGGESTED READINGS

- M. Goossens, F. Mittelbach, and A. Samarin, "The LaTeX Companion, Addison-Wesley.
- E. Krishnan, LATEX Tutorials: A Primer, Indian TEX Users Group.
- Langtangen, H. Petter. *A primer on scientific programming with Python*. Springer-

Verlag Berlin Heidelberg, 2016.

- Matthes, Eric. *Python crash course: A hands-on, project-based introduction to programming 3rd Edition)*. no starch press, 2023.
- Johansson, Robert. *Numerical Python: A Practical Techniques Approach for Industry*. Apress, 2015.
- "Python Plotting with Matplotlib" by Ben Root.

SEMESTER VI

Semester 6

Course Code	Title of the Course	Type of the Course	Credit	Hours/ Week	Hour Distribution /week			
					L	T	P	O
24SACMAT6DA301	Mathematical Analysis	Discipline Specific Component - DSC A	4	5	3	0	1	0
24SACMAT6DA302	Fundamentals of Linear Algebra	Discipline Specific Component - DSC A	4	5	3	0	1	0
24SACMAT6DE301	Application of Calculus and Linear Algebra in Finance	Discipline Specific Component - DSE	4	5	3	0	1	0
24SACMAT6DE302	Combinatorics	Discipline Specific Elective - DSE	4	4	4	0	0	0
24SACMAT6DE303	Fundamentals of Fluid Dynamics	Discipline Specific Elective - DSE	4	4	4	0	0	0
24SACMAT6DE304	Scilab for Calculations and Visual Presentations	Discipline Specific Elective - DSE	4	4	2	0	1	0
24SACMAT6VA301*	Mathematical Computation and Visualization with R	Foundation Component - VAC	3	3	1	0	1	0
24SACMAT6SE301*	Computations and Graphics using SageMath	Foundation Component - SEC	3	3	3	0	0	0
24SACMAT6SE302**	Number Theory for Programmers	Foundation Component - SEC	3	3	1	0	1	0

L — Lecture, T — Tutorial, P — Practical/Practicum , O — Others

***Can be opted only by students who have taken Mathematics as Major**

****Signature course by Department of Mathematics, St. Albert's College (Autonomous), Ernakulam, Can be opted only by students who have taken Mathematics as Major**

Department of Mathematics St. Albert's College (Autonomous) Ernakulam

Programme	**B Sc Mathematics**					
Course Name	**Mathematical Analysis**					
Type of Course	**Discipline Specific Component (DSC A)**					
Course Code	**24SACMAT6DA301**					
Course Level	**300**					
Course Summary	This real analysis course covers the fundamental concepts, includes continuity, uniform continuity, monotone and inverse functions, derivatives, the mean value theorem, L'Hôspital's Rules and Tayler's theorem. The course also explores the Riemann integral, Riemann integrable functions, and the Fundamental Theorem of Calculus. This curriculum provides students with a solid foundation in calculus and mathematical analysis, essential for advanced mathematical studies.					
Semester	6	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	0	1	0	5
Pre-requisites, if any	Limits and Convergence					

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
	Upon the successful completion of the course, the student will be able to		
1	Comprehend the concept of continuous functions and demonstrate proficiency in understanding their properties.	U, A	1,2,3

2	Understand uniform continuity, comparing and contrasting it with continuity.	U	1,2,3
3	Comprehend the concept of differentiation	U, A	1,2,3,10
4	Develop comprehensive understanding of the Mean Value Theorem, L'Hôpital's Rules and Taylor's theorem.	U, A	1,2,3,10
5	Understand the principles of Riemann integration, demonstrating proficiency in applying these concepts	An	1,2,3,10
6	Comprehend Riemann integrable functions and the fundamental theorem of calculus.	U, An	1,2,3,10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

<table>
<tr><th>Module</th><th>Units</th><th>Course description</th><th>CO No.</th><th>Hours</th></tr>
<tr><td rowspan="4">1</td><td>1.1</td><td>Continuous Functions</td><td>1</td><td rowspan="3">15</td></tr>
<tr><td>1.2</td><td>Combinations of Continuous Functions</td><td>1</td></tr>
<tr><td>1.3</td><td>Continuous Functions on Intervals</td><td>1</td></tr>
<tr><td colspan="4">Text 1: Chapter 5 - Sections: 5.1 (Concepts, statements of the theorems and problems only), 5.2 (Theorems 5.2.4 and 5.2.5 – statements only), 5.3 (Theorems 5.3.4 and 5.3.5 – Statements only)</td></tr>
<tr><td rowspan="4">2</td><td>2.1</td><td>Uniform Continuity</td><td>2</td><td rowspan="3">20</td></tr>
<tr><td>2.2</td><td>Monotone and Inverse Functions</td><td>2</td></tr>
<tr><td></td><td>Problems (Practicum)</td><td>2</td></tr>
<tr><td colspan="4">Text 1: Chapter 5 - Sections: 5.4 (up to 5.4.8) (Theorems 5.4.2 and 5.4.8 –
Statements only), 5.6 (up to 5.6.5). (Theorems 5.6.4 and 5.6.5 –</td></tr>
</table>

	Statements only)			
3	3.1	The Derivative	3	**20**
	3.2	The Mean Value Theorem	4	
	3.3	Intermediate Value Property of Derivatives	4	
	3.4	L'Hospital's Rules	4	
	3.5	Taylor's Theorem	4	
		Problems (Practicum)	**3, 4**	
	Text 1: Chapter 6 - Sections: 6.1(up to 6.1.7), 6.2.1 to 6.2.8, 6.2.11 to 6.2.13, 6.3 (Theorems 6.3.3 and 6.3.5- statements only), 6.4.1 to 6.4.3 (Theorem 6.4.1- Statement only)			
4	4.1	Riemann Integral	5	**20**
	4.2	Riemann Integrable Functions	6	
	4.3	The Fundamental Theorem	6	
		Problems (Practicum)	**5, 6**	
	Text 1: Chapter 7 - Sections: 7.1, 7.2 (Theorem 7.2.9 – statement only) & 7.3 (up to 7.3.9)			
5	**Teacher Specific Contents** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**			

Practicum
• Practicum is designed to provide supervised practical application of theoretical knowledge and skills. • Its purpose is to encourage creativity and develop Problem solving skills. • The practicum component is to be done in the classroom under the strict guidance of the teachers. • A minimum of 30 problems is to be solved, and a handwritten copy of the solutions should be kept in the department.

<table>
<tr><td rowspan="2">Teaching and Learning Approach</td><td colspan="6">Classroom Procedure (Mode of transaction)</td></tr>
<tr><td colspan="6">Lecture, Tutorial and Activity oriented</td></tr>
<tr><td rowspan="21">Assessment Types</td><td colspan="6">MODE OF ASSESSMENT</td></tr>
<tr><td>A</td><td colspan="5">Continuous Comprehensive Assessment (CCA) [30 marks]</td></tr>
<tr><td rowspan="7"></td><td colspan="3">Components</td><td colspan="2">Mark Distribution</td></tr>
<tr><td colspan="3">Module Test- I</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test- II</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test- III</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test- IV</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Assignment/Seminar</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Quiz/Viva voce</td><td colspan="2">5 Marks</td></tr>
<tr><td>B</td><td colspan="5">End Semester Evaluation (ESE)</td></tr>
<tr><td rowspan="7"></td><td colspan="5">Question Pattern
[Maximum Time 2 Hours, Maximum Marks 70]</td></tr>
<tr><td rowspan="2">Module</td><td>Part A</td><td>Part B</td><td>Part C</td><td rowspan="2">Total</td></tr>
<tr><td>1 Mark (MCQ)</td><td>5 Marks</td><td>10 Marks</td></tr>
<tr><td>I</td><td>5</td><td>2</td><td>1</td><td>8</td></tr>
<tr><td>II</td><td>5</td><td>2</td><td>1</td><td>8</td></tr>
<tr><td>III</td><td>5</td><td>2</td><td>1</td><td>8</td></tr>
<tr><td>IV</td><td>5</td><td>2</td><td>1</td><td>8</td></tr>
</table>

		Total no of questions	**20**	**8**	**4**	**32**
		Number of questions to be answered	**20**	**6**	**2**	**28**
		Total Marks	**20**	**30**	**20**	**70**

TEXT BOOK:

1. Bartle, Robert G., Sherbert, Donald R. *Introduction to Real Analysis (4th Edition)*, Wiley Internationals,2002.

SUGGESTED READINGS:

1. Denlinger, Charles. *Elements of real analysis*. Jones & Bartlett Learning, 2011.
2. Howie, John M. *Real analysis*. Springer Science & Business Media, 2006.
3. Abbott, Stephen. *Understanding analysis*. springer publication, 2015.
4. Ghorpade, Sudhir R., and Balmohan Vishnu Limaye. *A course in calculus and real analysis*. New York: Springer, 2006.
5. Kumar, Ajit, Kumaresan, S. *A basic course in real analysis*. CRC press, 2014.

ADVANCED READINGS:

1. Gelbaum, Bernard R., and John MH Olmsted. *Counterexamples in analysis*. Courier Corporation, 2003.
2. Rudin, Walter. *Principles of mathematical analysis*. Vol. 3. New York: McGraw-hill, 1976.
3. Apostol, Tom M. *Mathematical analysis*. 1974.
4. Royden, Halsey Lawrence, and Patrick Fitzpatrick. *Real analysis*. Vol. 2. New York: Macmillan, 1968.

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- Aproximations
- Piecewise linear functions
- Weierstrass aproximation theorem

- Continuity and gauges
- The nth root function
- Rational powers.
- Further applications of the Mean Value Theorem and inequalities.
- Proofs of L'Hospital's Rules
- Point-wise and uniform convergence
- Proof of all theorems of Section 5.1, theorems 5.2.4, 5.2.5, 5.3.4 and 5.3.5.
- Proof of theorems 5.4.2, 5.4.8, 5.6.4 and 5.6.5.
- Proof of theorems 6.3.3 and 6.3.5.
- Proof of theorem 7.2.9.

Department of Mathematics
St. Albert's College (Autonomous)
Ernakulam

<table>
<tr><td>Programme</td><td colspan="6">B Sc Mathematics</td></tr>
<tr><td>Course Name</td><td colspan="6">Fundamentals of Linear Algebra</td></tr>
<tr><td>Type of Course</td><td colspan="6">Discipline Specific Component (DSC A)</td></tr>
<tr><td>Course Code</td><td colspan="6">24SACMAT6DA302</td></tr>
<tr><td>Course Level</td><td colspan="6">300</td></tr>
<tr><td>Course Summary</td><td colspan="6">Linear Algebra is a fundamental tool in many areas of mathematics, science, engineering, economics, and data science. It also has applications in machine learning, providing the mathematical foundation for many algorithms and techniques. This course on Linear Algebra deals with the basic concepts like vector spaces, linear transformations, determinants, Eigen values and Eigen vectors.</td></tr>
<tr><td>Semester</td><td>6</td><td colspan="3">Credits</td><td>4</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Others</td></tr>
<tr><td>3</td><td>0</td><td>1</td><td>0</td><td>5</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="6">Algebra of Matrices, Gaussian Elimination Method, Solution and consistency of system of linear equations.</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
	Upon the successful completion of the course, the student will be able to		
1	Analyse the basic concepts of vector spaces	An	1,2,3,10
2	Illustrate the fundamental properties of linear transformations	A	2,3,10
3	Compute the eigen values and eigen vectors	A	3,10

4	Deduce the connections between determinants and other linear algebra concepts	An	1,2,3,10
5	Apply computational software and tools in linear algebra computations.	A	2,3,9
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	1.1	Vector Spaces: Definition and examples	3	1
	1.2	Subspaces	3	1
	1.3	Linear Combination of Vectors, Spanning Set, Linear Dependence and Independence of Vectors	3	1
	1.4	Basis of a Vector Space	3	1
	1.5	Dimension of a Vector Space	3	1
		Problems (Practicum)	5	1
		Text 1: Chapter 5	**20**	
2	2.1	Linear Mappings	3	2
	2.2	Kernel and Range of a Linear Mapping	3	2
	2.3	Bijective Linear Mappings	2	2
	2.4	Dimension Theorem	2	2

	2.5	Rank and Nullity	3	2
	2.6	Linear Isomorphism	3	2
		Problems (Practicum)	4	2
		Text 1: Chapter 6.	**20**	
3	3.1	Eigen Values and Eigen Vectors	7	3
	3.2	Characteristic Polynomial, Characteristic Equation and Algebraic Multiplicity	7	3
	3.3	Eigen Space and Geometric Multiplicity	6	3
		Text 1: Chapter 9 (up to and including theorem 9.2)	**20**	
4	4.1	Determinantal Mapping	2	4
	4.2	Determinant of a Matrix as a Determinantal Mapping	2	4
	4.3	Laplace Expansion	2	4
	4.4	Adjoint and Inverse of a Matrix	2	4
		Problems (Practicum)	7	4
		Text 1: Chapter 8 [Theorems (Statements only) and applications.]	**15**	
5	**Teacher Specific Contents** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**			

Practicum
• Practicum is designed to provide supervised practical application of theoretical knowledge and skills. • Its purpose is to encourage creativity and develop Problem solving skills. • The practicum component is to be done in the classroom under the strict guidance of the teachers. • A minimum of 30 problems is to be solved, and a handwritten copy of the solutions should be kept in the department.

<table>
<tr><td rowspan="2">Teaching and Learning Approach</td><td colspan="6">Classroom Procedure (Mode of transaction)</td></tr>
<tr><td colspan="6">Lectures, Tutorials, Interactive Sessions, Blended Learning</td></tr>
<tr><td rowspan="17">Assessment Types</td><td colspan="6">MODE OF ASSESSMENT</td></tr>
<tr><td>A</td><td colspan="5">Continuous Comprehensive Assessment (CCA) [30 marks]</td></tr>
<tr><td rowspan="7"></td><td colspan="3">Components</td><td colspan="2">Mark Distribution</td></tr>
<tr><td colspan="3">Module Test- I</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test- II</td><td colspan="2">5 Marks</td></tr>
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<tr><td rowspan="7"></td><td colspan="5">Question Pattern
[Maximum Time 2 Hours, Maximum Marks 70]</td></tr>
<tr><td rowspan="2">Module</td><td>Part A</td><td>Part B</td><td>Part C</td><td rowspan="2">Total</td></tr>
<tr><td>1 Mark (MCQ)</td><td>5 Marks</td><td>10 Marks</td></tr>
<tr><td>I</td><td>5</td><td>2</td><td>1</td><td>8</td></tr>
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<tr><td>IV</td><td>5</td><td>2</td><td>1</td><td>8</td></tr>
</table>

		Total no of questions	**20**	**8**	**4**	**32**
		Number of questions to be answered	**20**	**6**	**2**	**28**
		Total Marks	**20**	**30**	**20**	**70**

TEXT BOOK:

1. Blyth, T. S., and E. F. Robertson. *Basic linear algebra*, Second Edition, Springer, 2007.

SUGGESTED READINGS:

1. Strang, Gilbert. *Introduction to linear algebra (5th ed.)*. Wellesley-Cambridge Press, 2016.
2. Lay, D. C. *Linear algebra and its applications* (5th ed.). Pearson Education, 2018.
3. Axler, S. *Linear algebra Done Right* (3rd ed.). Springer, 2015.
4. Hoffman, K., & Kunze, R. *Linear algebra* (2nd ed.). Prentice Hall, 2009.
5. Lipschutz, S., Lipson, M. *Schaum's outline of theory and problems of linear algebra* (4th ed.). McGraw-Hill, 2009.
6. Thamban Nair, M., Singh, A. *Linear Algebra*. Springer, 2018.
7. Anton, H. *Elementary linear algebra* (12th ed.). Wiley, 2019.
8. Kumaresan, S. *Linear Algebra: A Geometric Approach*. PHI Learning, 2015.
9. Bronston, T. A., Costa, A. C. R. *Linear algebra: An introduction* (4th ed.),Academic Press, 2013.
10. Video lectures of Gilbert Strang hosted by MITOpenCourseWare available at https://ocw.mit.edu/courses/18-06-linear-algebra-spring-2010/video_galleries/video-lectures/

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- Proofs of theorems in Module 4
- Use of computational software or tools (like Python, Sagemath etc.) to perform computations in the modules 1 to 4 efficiently

Department of Mathematics St. Albert's College (Autonomous) Ernakulam

Programme	**B.Sc. Mathematics**					
Course Name	**Applications of Calculus and Linear Algebra in Finance**					
Type of Course	**Discipline Specific Elective (DSE)**					
Course Code	**24SACMAT6DE301**					
Course Level	**300**					
Course Summary	The goal of this course is to give the students a deeper understanding and working Knowledge of the application of mathematical concepts in Economic Analysis, via more sophisticated, realistic, and interesting models.					
Semester	**6**	Credits			**4**	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		2	0	1	0	4
Pre-requisites, if any	A deeper understanding of mathematical Analysis and Algebra					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
	Upon the successful completion of the course, the student will be able to		
1	Apply the concept of single variable and several variable calculus to the problems in Economics.	A	2,3,6
2	Analyse the money market and goods market and understand the trading strategy and use it effectively	An	1,2,6.7
3	Create an optimum solution in terms of productivity and profitability for economic problems	C	2,3,6.10

4	Apply Pareto optimality conditions	A	2,3,7,10
****Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)***			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Application of Calculus in Finance**			
	1.1	Production Functions, Cost Functions, Revenue and Profit Functions, Demand Functions and Elasticity **(Practicum)** **Exercise problems (Text 1)**	4	1
	1.2	Base 10 Logarithms, Base e Logarithms, Present Value, Annuities, Optimal Holding Time	4	1
	1.3	Economic Interpretation, Marginal Products, Elasticity, Geometric Interpretation, an application of higher derivatives in economics, Exercise problems of section 3.6,14.3,14.8 **(Practicum)** **Problems on Elasticity Text II (section 7.7 Exercise)**	4	1
	1.4	System of implicit function (proof excluded) Comparative statics, Simpson's paradox, Exercise problems **(Practicum)** **Exercise Problems of section 15.4 text I, Problems related to Comparative statics Text II (section 13.7)**	3	1
		Text 1: Chapter 3 - Section: 3.6; Chapter 5 - Sections: 5.3, 5.6; Chapter 14 - Sections: 14.2, 14.3, 14.8(An Economic application); Chapter 15- Sections: 15.3, 15.4 & 15.6	**15**	
2	**Linear Algebra in Finance**			

	2.1	**EXAMPLES OF LINEAR MODELS** Example 1: Tax Benefits of Charitable Contributions, Example 2: Linear Models of Production, Example 3: Markov Models of Employment, Example 4: IS-LM Analysis, Example 5: Investment and Arbitrage	4	2
	2.2	Application to Portfolio Theory, IS-LM analysis via Cramer'S Rule **(Practicum)** **Exercise problems Text1 section 9.3**	4	2
	2.3	Budget Sets in Commodity Space, Input Space, Probability Simplex	4	2
	2.4	The Investment Model, IS-LM Analysis, Supply demand **(Practicum)** **Exercise 10.42 Text 1(Section 10.7)**	3	2
		Text 1: Chapter 6- Section: 6.2; Chapter 7- Section: 7.4 (Application to Portfolio Theory); Chapter 9- Section:9.3; Chapter 10- Section: 10.7; Chapter 26- Section: 26.4	**15**	
3		**Optimization in Finance**		
	3.1	Quadratic forms, Definiteness of Quadratic forms, Second Order Conditions and Convexity, Conic Sections, The Definiteness of Diagonal Matrices, The Definiteness of 2 X 2 Matrices	4	3
	3.2	Definiteness and Optimality: One Constraint, Other Approaches, Profit-Maximizing Firm, Discriminating Monopolist, Least Squares Analysis **(Practicum)** **Exercise of section 16.3 Text 1**	4	3
	3.3	Homogeneous Function, Definition and Examples, Homogeneous Functions in Economics, Properties of	4	3

		Homogeneous Functions, A Calculus Criterion for Homogeneity		
	3.4	Economic Applications of Euler's Theorem, Homogenizing a Function, Economic Applications of Homogenization, cardinal versus ordinal utility	3	3
		Text 1: Chapter 16- Sections: 16.1 to 16.3; Chapter 17- Section: 17.5; Chapter 20- Sections: 20.1 to 20.3	**15**	
4	**Advanced Calculus in Finance**			
	4.1	Concave functions in Economics, quasi concave and quasi convex Functions, Calculus Criteria, Pseudo concave functions,	5	4
	4.2	Concave programming-Unconstrained Problems, Constrained Problems, Saddle Point Approach **(Practicum)** **Exercise of section 21.5 Text 1**	5	4
	4.3	Utility Maximization, The Demand Function, The Indirect Utility Function, The Expenditure and Compensated Demand Functions, The Slutsky Equation, profit and cost, The Profit- Maximizing Firm, The Cost Function	5	4
	4.4	Necessary Conditions for a Pareto Optimum Sufficient Conditions for a Pareto Optimum The Fundamental Welfare Theorems Competitive Equilibrium, Fundamental Theorem of Welfare Economics	5	4
		Text 1: Chapter 21- sections: 21.2(Concave functions in Economics)21.3 to 21.5; Chapter 22- sections: 22.1 to 22.4(proof of theorems from all sections excluded)	**20**	
5	**Teacher Specific Contents** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)*			

	This content will be evaluated internally

<table>
<tr><td rowspan="2">Teaching and Learning Approach</td><td colspan="6">Classroom Procedure (Mode of transaction)</td></tr>
<tr><td colspan="6">Lecture, Teaching, Interactive Instruction, Seminar, Group Assignment, Library Work and Group Discussion</td></tr>
<tr><td rowspan="20">Assessment Types</td><td colspan="6">MODE OF ASSESSMENT</td></tr>
<tr><td>A</td><td colspan="5">Continuous Comprehensive Assessment (CCA) [30 marks]</td></tr>
<tr><td rowspan="7"></td><td colspan="3">Components</td><td colspan="2">Mark Distribution</td></tr>
<tr><td colspan="3">Module Test- I</td><td colspan="2">5 Marks</td></tr>
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<tr><td>Total Marks</td><td>20</td><td>30</td><td>20</td><td>70</td></tr>
</table>

TEXT BOOKS:

1. Carl P. Simon and Lawrence, Mathematics for Economists, Blume Viva Books, 2018
2. Knut Sydsaeter, Peter Hammond, Arne Strom, Essential Mathematics for Economic Analysis (4th Edition), Pearson Publication, 2012.

SUGGESTED READINGS:

1. Chiang, C., Fundamental Methods of Mathematical Economics, McGraw Hills, *(Latest Edition).*
2. Budnick, Frank, Applied Mathematics for Business, Economics and Social Sciences, McGraw Hills Education, 2017..
3. Dowling E. T., Mathematics for economists, Schum Series (latest edition)
4. Rosser, Mike, Basic Mathematics for Economists, Routledge, Taylor & Francis Group, 2003.

ADVANCED READING:

1. Weber E. Jean, Mathematical Analysis, Business and Economic Applications (Latest Edition), Harper and Row Publishers

Department of Mathematics
St. Albert's College (Autonomous)
Ernakulam

Programme	**B.Sc. Mathematics**					
Course Name	**Combinatorics**					
Type of Course	**Discipline Specific Elective – DSE**					
Course Code	**24SACMAT6DE302**					
Course Level	**300**					
Course Summary	This course is a dynamic exploration of fundamental combinatorial concepts, focusing more on problems than theory. This approach aims to help students excel in competitive examinations by thoroughly covering exercise problems.					
Semester	6	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4	0	0	0	4
Pre-requisites, if any	Elementary Algebra, Basic Set theory, Basic understanding of Probability theory					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
	Upon the successful completion of the course, the student will be able to		
1	Provides a valuable toolkit for students preparing for competitive exams, offering a wealth of problems that sharpen logical reasoning and problem-solving skills	S	1, 2
2	Apply combinatorial methods to model and analyse real-world problems, emphasizing the translation of problems into mathematical language	An	1, 2, 3, 4

3	Demonstrate a deep understanding of basic combinatorial concepts, such as permutations, combinations, and the multiplication principle	U	1, 2,3
4	Develop critical thinking skills by analysing and synthesizing complex combinatorial problems, evaluating different approaches, and selecting the most suitable strategies.	I	1, 2, 3, 4, 10
****Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)***			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	CO No.	Hours
1	1.1	Two basic counting principles	1,2,4	15
	1.2	Permutations	1,3	
	1.3	Circular permutations	1,3	
	1.4	Combinations	1,3	
	Text 1: Chapter 1- Sections: 1.1 to 1.4			
2	2.1	The injection and bijection principles	1,4	15
	2.2	Arrangements and selections with repetitions	1,3	
	2.3	Distribution Problems	1,3	
	Text 1: Chapter 1- Sections: 1.5 to 1.7			
3	3.1	Introduction	1,2	

	3.2	The Pigeonhole principle	1,2	15
	3.3	More examples	1,2,3	
	3.4	Ramsey Type problems and Ramsey numbers	1,4	
	3.5	Bounds for Ramsey Numbers	1,4	
	Text 1: Chapter 3 - Sections: 3.1 to 3.5 (Theorems 3.5.1 and 3.5.2 – statements only)			
4	4.1	Introduction	1	15
	4.2	The Principle of Inclusion and Exclusion:	1,2	
	4.3	A generalization	1,2,4	
	4.4	Integer solutions and shortest routes	1,2,3	
	4.5	The Sieve of Eratosthenes and Euler function	1	
	Text 1: Chapter 4 - Sections: 4.1 to 4.4 & 4.7 (Theorem 4.3.1- statement only)			
5	**Teacher Specific Contents** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)**
	Lecture, Tutorial and Activity oriented

<table>
<tr><td rowspan="20">Assessment Types</td><td colspan="6">MODE OF ASSESSMENT</td></tr>
<tr><td>A</td><td colspan="5">Continuous Comprehensive Assessment (CCA) [30 marks]</td></tr>
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<tr><td>Total Marks</td><td>20</td><td>30</td><td>20</td><td>70</td></tr>
</table>

TEXTBOOK:

1. Chen, Chuan-Chong, Khee Meng Koh, and Koh Khee-Meng. *Principles and techniques in combinatorics*. World Scientific, 1992.

SUGGESTED READINGS:

1. Krishnamoorthy, V., Hoewood, E. *Combinatorics theory and applications*, 1986.
2. Hall, Jr. *Combinatorial Theory*, Wiley-Interscinice,1998.
3. Brualdi, RA. *Introductory Combinatorics*, PrenticeHall,1992
4. Bona Miklos. *A Walk Through Combinatorics – An Introduction to Enumeration and Graph Theory*, Second Edition, World Scientific, 2006.

ADVANCED READINGS:

1. Bóna, Miklós, ed. *Handbook of enumerative combinatorics*. Vol. 87. CRC Press, 2015.
2. Flajolet, Philippe, and Robert Sedgewick. *Analytic combinatorics*. Cambridge University press, 2009.
3. Harris, John M. *Combinatorics and graph theory*. Springer, 2008.

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- Binomial coefficients and multinomial coefficients.
- Stirling numbers of first kind
- Stirling numbers of second kind
- Surjective mappings and Stirling numbers of second kind
- Derangements and A generalization
- Proof of theorems 3.5.1 and 3.5.2
- Proof of theorems 4.3.1
- Generating functions
- Recurrence relations

Department of Mathematics
St. Albert's College (Autonomous)
Ernakulam

Programme	**B.Sc. Mathematics**					
Course Name	**Fundamentals of Fluid Dynamics**					
Type of Course	**Discipline Specific Elective – DSE**					
Course Code	**24SACMAT6DE303**					
Course Level	**300**					
Course Summary	This course aims to pave a strong foundation of fluid dynamics. The course is intended to impart knowledge regarding fluids, conservation laws and hence enable students to model basic fluid flow problems. The course begins with introducing the basics of fluid dynamics. The motion of fluids is described using Lagrangian and Eulerian methods. Then the fluid kinematics and the conservation laws are examined. Dimensional homogeneity and dimensional analysis are learned. This enables students to model basic flow problems. This acquired knowledge is used to model one-dimensional flow problems like the Bernoulli's equation and thereafter enable students to solve laminar flows of viscous incompressible fluids. Some real-life problems are modelled and solved mathematically to arrive at analytical solutions.					
Semester	6	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		1	0	1	0	3
Pre-requisites, if any						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
Upon the successful completion of the course, the student will be able to:			
1	Know the fundamentals of fluid mechanics	R	1, 2, 3, 10.
2	Understand the methods to describe fluid motion.	U	1, 2, 3, 10.
3	Learn fluid kinematics and the laws of conservation to model fluid flows.	U	1, 2, 3.
4	Apply the acquired knowledge to model one- dimensional fluid flow.	A	1, 2, 3, 7, 10.
5	Analyse the dimensional homogeneity of the physical equations.	An	1, 2, 3.
6	Model laminar flow of viscous incompressible fluids and arrive at analytical solutions.	An	1, 2, 3, 10.
****Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)***			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	CO No.	Hours
1		**Fluids & fluid motion**		15
	1.1	Fluid, Isotropy, Fluid Properties.	1	
	1.2	Viscous and Inviscid fluids, Important types of flows.	1	
	1.3	Results of vector analysis.	1	
	1.4	Methods to describe fluid motion: Lagrangian and Eulerian methods.	2	

	1.5	Velocity and acceleration of a fluid particle, Material, local and convective derivatives.	2	
	Text 1: Chapter 1 – Sections: 1.1 to 1.6; Chapter 2 – Sections: 2.1 to 2.6.			
2	**Fluid kinematics & Conservation Laws**			15
	2.1	Stream line, Path line, Streak line, Stream tube.	2, 3	
	2.2	Equation of Continuity (Cartesian form).	3	
	2.3	Equation of Motion (Cartesian form): The Navier-Stokes equations.	3	
	2.4	The Energy equation.	3	
	Text 1: Chapter 2 – Sections: 2.7 to 2.9, 2.20 to 2.25; Chapter 3 – Sections: 3.1 & 3.9.			
3	**One-dimensional flow & dimensional analysis**			15
	3.1	One-Dimensional flow: Bernoulli's equation. Bernoulli's Theorem.	4	
	3.2	Flow from a tank through a small orifice: Torricelli's theorem.	4	
	3.3	Dynamical similarity and Inspection analysis: Reynold's principle of similarity.	5	
	3.4	Dimensional analysis using Rayleigh's Technique.	5	
	Text 1: Chapter 4 – Sections: 4.1, 4.2, 4.4A; Chapter 15 – Sections: 15.1 to 15.5, 15.13 & 15.14.			
4	**Laminar flows of viscous incompressible fluids**			15

	4.1	Flow between parallel flat plates: Plane Couette flow.	6	
	4.2	Couette flow.	6	
	4.3	Plane Poiseuille flow.	6	
	Text 1: Chapter 16 – Sections: 16.1 to 16.3D.			
5	**Teacher Specific Contents** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)**		
	Lecture and Tutorial Practical Demonstration Using Appropriate Software.		
Assessment Types	**MODE OF ASSESSMENT**		
	A	**Continuous Comprehensive Assessment (CCA) [30 marks]**	
		Components	**Mark Distribution**
		Module Test- I	5 Marks
		Module Test- II	5 Marks
		Module Test- III	5 Marks
		Module Test- IV	5 Marks
		Assignment/Seminar	5 Marks
		Quiz/Viva voce	5 Marks
	B	**End Semester Evaluation (ESE)**	
		Question Pattern **[Maximum Time 2 Hours, Maximum Marks 70]**	

		Module	Part A **1 Mark (MCQ)**	Part B **5 Marks**	Part C **10 Marks**	Total
		I	5	2	1	**8**
		II	5	2	1	**8**
		III	5	2	1	**8**
		IV	5	2	1	**8**
		Total no of questions	**20**	**8**	**4**	**32**
		Number of questions to be answered	**20**	**6**	**2**	**28**
		Total Marks	**20**	**30**	**20**	**70**

TEXT BOOK:

1. Raisinghania, M.D. *Fluid Dynamics: With Complete Hydrodynamics and Boundary Layer Theory*, Eleventh Revised Edition, S. Chand and Company Ltd, 2013.

SUGGESTED READINGS:

1. Yuan, S.W. *Foundations of Fluid mechanics*, Prentice Hall of India, 2001.
2. Chandrasekharaiah, D. S., Debnath, L. *Continuum Mechanics*, Academic Press, 2014.
3. Batchelor, G.K. *An Introduction to Fluid Dynamics*, Cambridge University Press, 2000.
4. Kundu, P.K., Cohen., I.M., Dowling D.R. *Fluid Mechanics*, Fifth Edition, 2012.

ADVANCED READINGS:

1. White, F.M. *Fluid Mechanics*, Tata Mc Graw Hill, 2011.
2. Schlichting, H. *Boundary Layer Theory*, Tata Mc Graw Hill, 2002.

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- Classify different types of fluids and draw a graph to differentiate Newtonian and non-Newtonian fluids.
- Visualize the streamline of a fluid flow for an instantaneous velocity using Wolfram Alpha.
- Represent the velocity and acceleration of a moving fluid particle using Sci-lab software.
- Inspect the dimensional homogeneity of some well-known physical equations.
- Visualize the Couette flow using MATLAB software.
- Compare the importance of Boundary layer flows and Viscous laminar flows.

Department of Mathematics
St. Albert's College (Autonomous)
Ernakulam

<table>
<tr><td>Programme</td><td colspan="6">B.Sc. Mathematics</td></tr>
<tr><td>Course Name</td><td colspan="6">Scilab for Calculations and Visual Presentations</td></tr>
<tr><td>Type of Course</td><td colspan="6">Discipline Specific Elective – DSE</td></tr>
<tr><td>Course Code</td><td colspan="6">24SACMAT6DE304</td></tr>
<tr><td>Course Level</td><td colspan="6">300</td></tr>
<tr><td>Course Summary</td><td colspan="6">The course is designed for doing computations, matrix operations, solving system of linear equations, plotting data, visualisation of curves and solving differential equations using Scilab.</td></tr>
<tr><td>Semester</td><td>6</td><td colspan="3">Credits</td><td>4</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Others</td></tr>
<tr><td>2</td><td>0</td><td>1</td><td>0</td><td>4</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="6">Fundamental knowledge on algebraic equations, mathematical functions, matrices, differential equations.</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
	Upon the successful completion of the course, the student will be able to		
1	Understand the basic commands used for fundamental mathematical calculations using Scilab	U,S	2, 10
2	Apply basic programming techniques in Scilab to compute the value of expressions involving mathematical functions.	A,S	1, 2
3	Apply Scilab to do various operations in Matrices and	A,S	1, 2

	solving system of linear equations.		
4	Apply Scilab to plot various mathematical functions, expressions and solving differential equations.	A,S	2
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	CO No.	Hours
1	1.1	The General Environment and Console, Simple Numerical Calculations	1	**12**
	1.2	The Menu bar, The Editor	1,2	
	1.3	The Graphics Window (Graphics for Plotting, Modifying a Plot, Online help), Windows Management and Workspace Customization	4	
	Text 1: Chapter 1 – Become Familiar with Scilab			
2	2.1	Variables Assignment and Display (Variables, Functions)	1	**15**
	2.2	Variables Assignment and Display (Display - Brackets : Vectors and Matrices, Strings)	1,2	
	2.3	Loops – for, while, Tests – if.. then.. else.. Tests	1,3	
	Text 1: Chapter 2 – Programming – sections: Variables Assignments and Display to Tests			
3	3.1	2 D and 3D Plots (Basic Plots - of Mathematical Functions, Plots of Plane Curves)	4	**18**
	3.2	2 D and 3D Plots (Plots of Sequence of Points, Bivariate Statistical Data)	4	

	3.3	2 D and 3D Plots (Plots in 3 dimensions – surfaces and curves)	4	
	3.4	2 D and 3D Plots (Simulations and Statistics, Statistics - Plotting Data using Bar graphs)	5	
	Text 1: Chapter 2 – Programming – sections: 2 D and 3D Plots			
4	4.1	Additional Information on Matrices and Vectors (Accessing Elements, Operations on Matrices)	3	**15**
	4.2	Additional Information on Matrices and Vectors (Solving Linear Systems, Some useful Functions - sort, length, sum and product)	3	
	4.3	Additional Information on Matrices and Vectors (Some useful Functions - unique, find) Accuracy Computation Solving Differential Equations	2, 4	
	Text 1: Chapter 2 Programming – sections: Additional Information on Matrices and Vectors to Solving Differential Equations			
5	**Teacher Specific Contents** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**			

Practicum
• Practicum is designed to provide supervised practical application of theoretical knowledge and skills. • Its purpose is to encourage creativity and develop Problem solving skills. • The practicum component is to be done in the classroom under the strict guidance of the teachers. • A minimum of 30 problems is to be solved, and a handwritten copy of the solutions should be kept in the department.

<table>
<tr><td rowspan="2">Teaching and Learning Approach</td><td colspan="6">Classroom Procedure (Mode of transaction)</td></tr>
<tr><td colspan="6">Interactive Instructions using ICT Tools
Hands on Training</td></tr>
<tr><td rowspan="22">Assessment Types</td><td colspan="6">MODE OF ASSESSMENT</td></tr>
<tr><td>A</td><td colspan="5">Continuous Comprehensive Assessment (CCA) [30 marks]</td></tr>
<tr><td rowspan="7"></td><td colspan="3">Components</td><td colspan="2">Mark Distribution</td></tr>
<tr><td colspan="3">Module Test- I</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test- II</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test- III</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test- IV</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Assignment/Seminar</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Quiz/Viva voce</td><td colspan="2">5 Marks</td></tr>
<tr><td>B</td><td colspan="5">End Semester Evaluation (ESE)</td></tr>
<tr><td rowspan="10"></td><td colspan="5">Question Pattern
[Maximum Time 2 Hours, Maximum Marks 70]</td></tr>
<tr><td rowspan="2">Module</td><td>Part A</td><td>Part B</td><td>Part C</td><td rowspan="2">Total</td></tr>
<tr><td>1 Mark (MCQ)</td><td>5 Marks</td><td>10 Marks</td></tr>
<tr><td>I</td><td>5</td><td>2</td><td>1</td><td>8</td></tr>
<tr><td>II</td><td>5</td><td>2</td><td>1</td><td>8</td></tr>
<tr><td>III</td><td>5</td><td>2</td><td>1</td><td>8</td></tr>
<tr><td>IV</td><td>5</td><td>2</td><td>1</td><td>8</td></tr>
<tr><td>Total no of questions</td><td>20</td><td>8</td><td>4</td><td>32</td></tr>
<tr><td>Number of questions to be answered</td><td>20</td><td>6</td><td>2</td><td>28</td></tr>
<tr><td>Total Marks</td><td>20</td><td>30</td><td>20</td><td>70</td></tr>
</table>

TEXT BOOK:

1. https://www.scilab.org/sites/default/files/Scilab_beginners.pdf

SUGGESTED READINGS:

1. https://scilab.in/textbook_companion/generate_book/845
2. https://www.scilab.org/sites/default/files/progscilab-v.0.10_en.pdf

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

1. Text 1 : Chapter 3 Useful Scilab Functions (Analysis, Probability and Statistics, Display and Plot, Utilities)

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<table>
<tr><td>Programme</td><td colspan="6">B Sc Mathematics</td></tr>
<tr><td>Course Name</td><td colspan="6">Mathematical Computation and Visualization with R</td></tr>
<tr><td>Type of Course</td><td colspan="6">Foundation Component - VAC</td></tr>
<tr><td>Course Code</td><td colspan="6">24SACMAT6VA301</td></tr>
<tr><td>Course Level</td><td colspan="6">300</td></tr>
<tr><td>Course Summary</td><td colspan="6">This course delves into the realm of mathematical computation and visualization using the powerful R programming language. Students will embark on a journey through the fundamentals of R, exploring its functionality and applications in various mathematical domains.</td></tr>
<tr><td>Semester</td><td>6</td><td colspan="3">Credits</td><td>3</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Others</td></tr>
<tr><td>1</td><td>0</td><td>1</td><td>0</td><td>3</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="6">NIL</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
	Upon the successful completion of the course, the student will be able to		
1	Apply R to represent and manipulate sets, including operations like union, intersection, and difference	U	1,2,4,10
2	Apply matrix concepts to represent and solve system of linear equations in R	A	1,2,4,10
3	Solve various matrix operations.	A	1,2,4,10

4	Compute determinants of matrices using R & employ Cramer's rule to solve system of linear equations in R	A	1,2,4,10
5	Apply R to analyse functions	A	1,2,4,10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	CO No.	Hours
1		**R FUNCTIONS AND AN OVERVIEW OF SETS USING R**		15
	1.1	Functions, Parameter versus Argument, Argument Order and Parameter Names, Environments, Scope	1	
	1.2	Sets, Venn diagram, Cardinality of sets, Implementing the Subset Function in R, Equality of Sets, Empty Set.	1	
	1.3	Operations on Sets – Intersection, Union, Complement, Cross Product of two sets.	1	
	Text 1: Chapter 1 - Sections: 1.2 to 1.6; Chapter 3- Sections: 3.1 to 3.9 & 3.11.			
2		**SYSTEM OF LINEAR EQUATIONS AND MATRICES IN R**		15
	2.1	Matrix & Vector in R	2	
	2.2	Solving a System of Linear Equations with R (Gaussian Elimination in R)	2	
	2.3	Matrix Operations in R - Addition, Scalar multiplication, Dot product, Transpose	3	
	2.4	Determinant, function, Cramer's rule in R	4	
	Text 2: Chapter 1 – Sections: 1.2.3, 1.2.7, 1.3.3, 1.3.7; Chapter 2 -Sections: 2.1, 2.2(2.2.1-2.2.3 & 2.2.7); Chapter 3 - Sections: 3.3 det( ) function only ,			

	3.3.4 {lab exercises using det( ) function}, 3.5.3 & 3.5.7.			
3		**PLOTTING GRAPHS IN R**		**15**
	3.1	Basic arithmetic, Define and Evaluate a Function, Graph a Function in R, Find Roots of a Function, Store Roots as a Variable and Display the First Root, Evaluate a Function with a Variable, Add a Point to a Graph, Evaluate a Function at Multiple Values, Add Multiple Points to a Graph	5	
	3.2	Define a Function from a Function, Define a Function and Graph It, Identify Intersection Points and Add Them to the Graph, Add a Line Segment to a Graph	5	
	Text 3: Chapter 1 (R codes 1.1 to 1.20),			
4	**Teacher Specific Contents** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**			

	Classroom Procedure (Mode of transaction)
Teaching and Learning Approach	The primary goal of this class is to enhance students' proficiency in mathematical computation and visualization using the R programming language. The course will cover fundamental mathematical concepts and their practical implementation through R. **Class Structure:** 1. **Introduction -** Outline the goals and expectations for the class 2. **Recap and Review -** Briefly review the key concepts covered 3. **Theory and Conceptual Understanding -** Discuss theoretical aspects and provide real-world examples 4. **Hands-On Computation with R -** Conduct practical exercises using R to reinforce mathematical concepts 5. **Group Project -** Assign a group project **Homework Assignment -** Assign relevant homework to reinforce learning

<table>
<tr><td rowspan="20">Assessment Types</td><td colspan="6">MODE OF ASSESSMENT</td></tr>
<tr><td>A</td><td colspan="5">Continuous Comprehensive Assessment (CCA) [25 marks]</td></tr>
<tr><td rowspan="6"></td><td colspan="3">Components</td><td colspan="2">Mark Distribution</td></tr>
<tr><td colspan="3">Module Test- I</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test- II</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test- III</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Assignment/Seminar</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Quiz/Viva voce</td><td colspan="2">5 Marks</td></tr>
<tr><td>B</td><td colspan="5">End Semester Evaluation (ESE)</td></tr>
<tr><td rowspan="10"></td><td colspan="5">Question Pattern
[Maximum Time 90 Minutes, Maximum Marks 50]</td></tr>
<tr><td rowspan="2">Module</td><td>Part A</td><td>Part B</td><td>Part C</td><td rowspan="2">Total</td></tr>
<tr><td>1 Mark (MCQ)</td><td>5 Marks</td><td>10 Marks</td></tr>
<tr><td>I</td><td>7</td><td>2</td><td>1</td><td>10</td></tr>
<tr><td>II</td><td>7</td><td>2</td><td>1</td><td>10</td></tr>
<tr><td>III</td><td>6</td><td>2</td><td>0</td><td>8</td></tr>
<tr><td>Total no of questions</td><td>20</td><td>6</td><td>2</td><td>28</td></tr>
<tr><td>Number of questions to be answered</td><td>20</td><td>4</td><td>1</td><td>11</td></tr>
<tr><td>Total Marks</td><td>20</td><td>20</td><td>10</td><td>50</td></tr>
</table>

TEXT BOOKS:

1. Claster, William B. *Mathematics and programming for machine learning with R: from the ground up*. CRC Press, 2021.
2. Yoshida, Ruriko. *Linear algebra and its applications with R*. CRC Press, 2021.
3. Pfaff, Thomas J. *Applied Calculus with R*. Springer International Publishing, 2023.

SUGGESTED READINGS:

1. Zuur, Alain F., Elena N. Ieno, and Erik HWG Meesters. *A Beginner's Guide to R*. New York: Springer, 2009.

2. Matloff, Norman. *The art of R programming: A tour of statistical software design*. No Starch Press, 2011.
3. Strang, Gilbert. *Introduction to linear algebra*. Wellesley-Cambridge Press, 2022.
4. Weir, Maurice D., et al. *Thomas' calculus: early transcendentals: based on the original work by George B. Thomas, Jr*. Addison-Wesley, 2006.

ADVANCED READINGS:

1. Emmert-Streib, Frank S., Salissou Moutari and Matthias Dehmer. *Mathematical Foundations of Data Science using R,* De Gruyter, 2022.
2. Jones, Owen, Robert Maillardet and Andrew Robinson. *Introduction to Scientific Programming and Simulation Using R*, 2nd edition, Chapman & Hall/CRC, 2014.

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- Any suitable topic from Textbook 2 can be included.

Department of Mathematics St. Albert's College (Autonomous) Ernakulam

Programme	**B Sc Mathematics**					
Course Name	**Computations and Graphics using SageMath**					
Type of Course	**Foundation Component - SEC**					
Course Code	**24SACMAT6SE301**					
Course Level	**300**					
Course Summary	The course is designed for doing Computations, Analysis, Linear Algebra, Plotting Data and Visualisation of curves using SageMath.					
Semester	**6**	Credits			**3**	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		1	0	1	0	3
Pre-requisites, if any	Fundamental Knowledge on algebraic equations, trigonometric functions, Sequences, Series, Power Series, Limits, Derivatives, Partial Derivatives, Matrices, Eigenvalues and Eigenvectors.					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
	Upon the successful completion of the course, the student will be able to		
1	Discuss the basic commands used for mathematical calculations using Sage Math	**U, S**	**1,2**
2	Apply basic programming skills in Sage Math to compute the limits and derivatives of various fuctions	**A, S**	**1,2,3,4**

3	Apply Sage Math to do various operations in Matrices.	**A, S**	**1,3,9**
4	Use SageMath to plot various mathematical functions and data structures.	**A, S**	**1,3,9,10**
***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)**			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	CO No.	Hours
1	**1.1**	Sage as a Calculator – First Computations Elementary Functions and Usual Constants On-line help and Automatic Completion	**1**	**20**
	1.2	Python Variables Symbolic Variables (Using Variables and Expressions) First Graphics (Graphics - Plotting Functions)	**1**	
	1.3	Symbolic Expressions and Simplification – Symbolic Expressions, Transforming Expressions, Usual Mathematical Functions, Assumptions, Some Pitfalls	**1**	
	1.4	Equations – Explicit Solving, Equations with no Explicit Solution	**2**	
	1.5	Analysis – Sums, Limits, Sequences, Power Series Expansions, Series, Derivatives, Partal Derivatives, Integrals	**2**	
	Text 1: Chapter 1 – Section: 1.2 (1.2.1 to 1.2.6); Chapter 2 - Sections: 2.1 to 2.3			
2	**2.1**	Basic Linear Algebra - Matrix Computations, Reduction of a Square	**3**	**13**

		Matrix		
	2.2	Elementary Constructs and Manipulations – Vector and Matrix Constructions	**3**	
	2.3	Basic Manipulations and Arithmetic on Matrices, Basic Operations on Matrices	**3**	
	Text 1: Chapter 2 – Section: 2.4 (2.4.3 to 2.4.4); Chapter 8 – Section: 8.1 (8.1.2 to 8.1.4))			
3	**3.1**	2 D Graphics - Graphical Representation of Functions	**4**	**12**
	3.2	Parametric Curves, Curve in Polar Co-ordinates, Curve defined by Implicit Equation	**4**	
	3.3	Data Plot, Displaying Solutions of Differential Equations, Evolute of a Curve	**4**	
	3.4	3 D Curves	**4**	
	Text 1: Chapter 4 – Sections: 4.1 & 4.2			
4	**Teacher Specific Contents** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)**		
	1. Interactive Instructions using ICT tools 2. Hands on Training		
	MODE OF ASSESSMENT		
	A	**Continuous Comprehensive Assessment (CCA) [25 marks]**	
		Components	**Mark Distribution**
		Module Test- I	**5** Marks

<table>
<tr><td rowspan="14">Assessment Types</td><td rowspan="4"></td><td colspan="3">Module Test- II</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test- III</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Assignment/Seminar</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Quiz/Viva voce</td><td colspan="2">5 Marks</td></tr>
<tr><td>B</td><td colspan="5">End Semester Evaluation (ESE)</td></tr>
<tr><td rowspan="9"></td><td colspan="5">Question Pattern
[Maximum Time 90 Minutes, Maximum Marks 50]</td></tr>
<tr><td rowspan="2">Module</td><td>Part A</td><td>Part B</td><td>Part C</td><td rowspan="2">Total</td></tr>
<tr><td>1 Mark (MCQ)</td><td>5 Marks</td><td>10 Marks</td></tr>
<tr><td>I</td><td>7</td><td>2</td><td>1</td><td>10</td></tr>
<tr><td>II</td><td>7</td><td>2</td><td>1</td><td>10</td></tr>
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<tr><td>Total Marks</td><td>20</td><td>20</td><td>10</td><td>50</td></tr>
</table>

TEXT BOOK:

1. Paul Zimmermann, Alexandre Casamayou, Nathann Cohen, Guillaume Connan, Thierry Dumont, Laurent Fousse, François Maltey, Matthias Meulien, Marc Mezzarobba, Clément Pernet, Nicolas M. Thiéry, Erik Bray, John Cremona, Marcelo Forets, Alexandru Ghitza, Hugh Thomas. *Computational Mathematics with SageMath.*, SIAM, 2018

SUGGESTED READINGS:

1. Razvan A. Mezei. Introduction to Programming Using SageMath, Wiley, 2020.
2. The Sage Development Team , Tutorial Release 10.2 ,2023, (https://doc.sagemath.org/pdf/en/tutorial/sage_tutorial.pdf).
3. Gregory V. Bard, William Stein, Sage for Undergraduates, American Mathematical Society , 2015)

4. Robert Beezer, A first course in Linear algebra, Congruent Press,2015, (http://linear.ups.edu/)
5. Tom Judson and Robert Beezer, Abstract Algebra Theory and Applications., open source textbook supported by National Science Foundation, 2022 (http://abstract.ups.edu/)
6. Razvan A Mezei , An Introduction to SAGE Programming: With Applications to SAGE Interacts for Numerical Methods by, Springer, 2015

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Programme	**B Sc Mathematics**					
Course Name	**Number Theory for Programmers**					
Type of Course	SEC					
Course Code	**24SACMAT6SE302****					
Course Level	**300**					
Course Summary	The main goal of this course is to teach the basics of Number Theory and how the information is stored and processed in the memory of computer and other digital systems. This course is to help all those aspiring programmers to build their sound fundamentals with Number Theory.					
Semester	**6**	Credits			**3**	Total Hours/ Week
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		1	0	1	0	3
Pre-requisites, if any	**Class XII pass with Mathematics, Basic Understading of Python Programming/C++**					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PO No
1	Demonstrate a comprehensive understanding of basic number theory concepts.	***U, A***	
2	Analyze and interpret mathematical properties of integers, prime numbers, and modular arithmetic.	***An, U***	
3	Apply number theory principles to design and implement efficient algorithms.	***A, C***	
4	Apply number theory principles to real-world scenarios, including cryptography, data security, and optimization problems.	***A, C***	

5	Develop problem-solving skills and strategies that leverage number theoretic principles.	**C**	
***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)**			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	1.1	The well-ordering property	2	1,2
	1.2	Divisibility	2	1,2
	1.3	Representation of integers	3	1,2
	1.4	Computer operations with integers	3	1,2
	1.5	Prime Numbers	3	1,2
	1.6	Computer Projects(Activity)	5	3
		(Sections 1.1 to 1.5 of the text)		
2	2.1	Greatest Common Divisors	2	1,2
	2.2	The Euclidean Algorithm	2	1,2
	2.3	The Fundamental Theorem of Arithmetic	2	1,2
	2.4	Factorization of integers and the Fermat numbers	3	1,2
	2.5	Linear Diophantine equation	4	1,2
	2.6	Computer Projects(Activity)	5	3

		(Sections 2.1 to 2.5 of the text)		
3	3.1	Introduction to congruences	3	5
	3.2	Linear congruences	3	5
	3.3	The Chinese remainder theorem	3	5
	3.4	Systems of linear congruence	4	5
		Computer Projects(Activity)	5	3,4
		(Sections 3.1, 3.2, 3.3, 3.4 of the text)		
4	4.1	Divisibility test	3	5
	4.2	The perpetual calendar	3	4
	4.3	Round-robin tournaments	3	4
	4.4	Computer file storage and hashing functions	4	4
		Computer Projects(Activity)	5	3,4
		(Sections 4.1, 4.2, 4.3, 4.4 of the text)		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)**		
	Lecture, Teaching, Interactive Instruction, Seminar, Group Assignment, Library Work and Group Discussion		
Assessment Types	**MODE OF ASSESSMENT**		
	A	**Continuous Comprehensive Assessment (CCA) [30 marks]**	
		Components	**Mark Distribution**
		Module Test- I	**5** Marks
		Module Test- II	**5** Marks
		Module Test- III	**5** Marks

		Module Test- IV	**5** Marks
		Assignment/Seminar	**5** Marks
		Quiz/Viva voce	**5** Marks
	B	**End Semester Evaluation (ESE)**	
		Question Pattern **[Maximum Time 2 Hours, Maximum Marks 70]**	

Module	Part A	Part B	Part C	Total
	1 Mark (MCQ)	**5 Marks**	**10 Marks**	
I	5	2	1	**8**
II	5	2	1	**8**
III	5	2	1	**8**
IV	5	2	1	**8**
Total no of questions	**20**	**8**	**4**	**32**
Number of questions to be answered	**20**	**6**	**2**	**28**
Total Marks	**20**	**30**	**20**	**70**

Textbook:

1. K. H. Rosen, "Elementary number theory and its application," 5th edition, Pearson Education Inc. Press, 2005

SUGGESTED READINGS

1. David M Burton - Elementary Number Theory, 7thEdition, McGraw Hill Education(India) Private Ltd.

2. Neal Koblitz, A Course in Number Theory and Cryptography, 2nd Edition, Springer Verlag.

SEMESTER VII

Semester 7

Course Code	Title of the Course	Type of the Course	Credit	Hours/ Week	Hour Distribution / week			
					L	T	P	O
24SACMAT7CC401	Advanced Linear Algebra	Discipline Capstone Component (Advanced) - DCC	4	5	3	0	1	0
24SACMAT7CC402	Theory of Complex Functions	Discipline Capstone Component (Advanced) - DCC	4	4	4	0	0	0
24SACMAT7CC403	Introduction to Metric Spaces	Discipline Capstone Component (Advanced) - DCC	4	4	4	0	0	0
24SACMAT7CE401	Advanced Theory of Groups and Rings	Discipline Capstone Component (Advanced) - DCC	4	4	4	0	0	0
24SACMAT7CE402	Real Analysis	Discipline Capstone Component (Advanced) - DCC	4	4	4	0	0	0
24SACMAT7CE403	Graph Theory	Discipline Capstone Component (Advanced) - DCC	4	4	4	0	0	0

L — Lecture, T — Tutorial, P — Practical/Practicum , O — Others

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<table>
<tr><td>Programme</td><td colspan="6">B Sc Mathematics</td></tr>
<tr><td>Course Name</td><td colspan="6">Advanced Linear Algebra</td></tr>
<tr><td>Type of Course</td><td colspan="6">Discipline Capstone Component (Advanced) – DCC</td></tr>
<tr><td>Course Code</td><td colspan="6">24SACMAT7CC401</td></tr>
<tr><td>Course Level</td><td colspan="6">400</td></tr>
<tr><td>Course Summary</td><td colspan="6">This course on linear algebra provides a comprehensive introduction to the fundamental concepts and techniques of linear algebra. The course covers a wide range of topics, including vector spaces, coordinates, linear transformations, linear functionals, matrix of linear transformations, dual spaces, characteristic values, annihilating polynomials, invariant subspaces, simultaneous triangulisation and diagonalisation, direct sum decomposition, and invariant direct sums.</td></tr>
<tr><td>Semester</td><td>7</td><td colspan="3">Credits</td><td>4</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Others</td></tr>
<tr><td>3</td><td>0</td><td>1</td><td>0</td><td>5</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="6">Basic definitions, properties and theorems on Fields, Vector spaces, subspaces, basis and dimension.</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
	Upon the successful completion of the course, the student will be able to		
1	Analyse finite and infinite dimensional vector spaces and subspaces over a field and their properties including basis structure of vector spaces	An	1,2,3

2	Use the definition and properties of linear transformations and matrices of linear transformations and change of basis, including kernel, range and isomorphism	A, An	2,3,10
3	Compute the characteristic polynomial, eigenvectors, eigenvalues and eigenspaces, as well as the geometric and the algebraic multiplicities of an eigenvalue and apply the basic diagonalization result	A, E	2,3
4	Understand the basic theory of Simultaneous triangulations, Direct sum decompositions and Invariant direct sums	U, An	1,2,3,10
5	Utilize Python to perform computations efficiently in linear algebra.	S, A	2,3,8,10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	CO No.	Hours
1	1.1	Review on Fields, Vector spaces, subspaces, basis and dimension (Theorems-Statements only)	1	**20**
	1.2	Coordinates	1, 2	
	1.3	Linear transformations and Algebra of Linear Transformations	1, 2	
	1.4	Isomorphism	1, 2	
		Problems (Practicum)	1,2	
	Text 1: Chapter 1 – Section: 1.1; Chapter 2 – Sections: 2.1 to 2.4; Chapter 3 – Sections: 3.1 to 3.3.			
2	2.1	Representation of transformations by matrices	1, 2	**20**
	2.2	Linear functionals and dual space	1, 2	

	2.3	Double dual	1, 2	
		Problems (Practicum)	1,2	
	Text 1: Chapter 3 – Sections: 3.4 to 3.6			
3	3.1	Characteristic Values	3	**20**
	3.2	Diagonalizable linear operators	3,4	
	3.3	Annihilating polynomials	2,3,4	
	3.4	Cayley Hamilton Theorem	3,4	
	3.5	Invariant subspaces	3,4	
		Problems (Practicum)	2,3,4	
	Text 1: Chapter 6 – Sections: 6.1 to 6.4.			
4	4.1	Simultaneous triangulation; simultaneous diagonalization	3,4	**15**
	4.2	Direct sum Decompositions	3,4	
	4.3	Invariant Direct Sums	3,4	
		Problems (Practicum)	3,4,5	
	Text 1: Chapter 6 – Sections: 6.5 to 6.7.			

<table>
<tr><td rowspan="3">5</td><td>Teacher Specific Contents</td></tr>
<tr><td>(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)</td></tr>
<tr><td>This content will be evaluated internally</td></tr>
</table>

Practicum
- Practicum is designed to provide supervised practical application of theoretical knowledge and skills.   - Its purpose is to encourage creativity and develop Problem solving skills.   - The practicum component is to be done in the classroom under the strict guidance of the teachers.   - A minimum of 30 problems is to be solved, and a handwritten copy of the solutions should be kept in the department.

<table>
<tr><td rowspan="2">Teaching and Learning Approach</td><td colspan="6">Classroom Procedure (Mode of transaction)</td></tr>
<tr><td colspan="6">Lectures, Tutorials, Interactive Sessions, Blended Learning</td></tr>
<tr><td rowspan="14">Assessment Types</td><td colspan="6">MODE OF ASSESSMENT</td></tr>
<tr><td>A</td><td colspan="5">Continuous Comprehensive Assessment (CCA) [30 marks]</td></tr>
<tr><td rowspan="7"></td><td colspan="3">Components</td><td colspan="2">Mark Distribution</td></tr>
<tr><td colspan="3">Module Test- I</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test- II</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test- III</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test- IV</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Assignment/Seminar</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Quiz/Viva voce</td><td colspan="2">5 Marks</td></tr>
<tr><td>B</td><td colspan="5">End Semester Evaluation (ESE)</td></tr>
<tr><td rowspan="3"></td><td colspan="5">Question Pattern
[Maximum Time 2 Hours, Maximum Marks 70]</td></tr>
<tr><td rowspan="2">Module</td><td>Part A</td><td>Part B</td><td>Part C</td><td rowspan="2">Total</td></tr>
<tr><td>1 Mark (MCQ)</td><td>5 Marks</td><td>10 Marks</td></tr>
</table>

		I	5	2	1	**8**
		II	5	2	1	**8**
		III	5	2	1	**8**
		IV	5	2	1	**8**
		Total no of questions	**20**	**8**	**4**	**32**
		Number of questions to be answered	**20**	**6**	**2**	**28**
		Total Marks	**20**	**30**	**20**	**70**

TEXT BOOK:

1. Hoffman, K., Kunze, R. Linear algebra: Second edition. Prentice-Hall of India Pvt. Ltd, 1992.

SUGGESTED READINGS:

1. Strang, G.. *Linear algebra and its applications*. Cengage Learning, 2016.
2. Lay, D. C., Lay, S. R., & McDonald, J. J. *Linear algebra and its applications* (5th ed.). Pearson, 2023.
3. Lang, S. *Introduction to linear algebra (2nd ed.).* Springer-Verlag New York, Inc, 1997.
4. Kumaresan, S. *Linear algebra: A geometrical approach*. Prentice-Hall of India,2000.
5. Axler, S. *Linear algebra done right* (4th ed.). Springer, 2023
6. Jänich, K. *Linear Algebra (Undergraduate Texts in Mathematics).* Springer-Verlag New York, 2014.
7. Banchoff, T. F., & Wermer, J. T. *Linear algebra through geometry (2nd ed.).* Springer,2002.
8. Friedberg, S. H., Insel, A. J., & Spence, L. E. *Linear algebra (4th ed.)*. Pearson, 2013.
9. Horn, R. A., & Johnson, C. R. *Matrix analysis (2nd ed.)*. Cambridge, UK: Cambridge University Press, 2013.
10. Thamban Nair, M., & Singh, A. *Linear Algebra.* Springer, 2018.
11. Video lectures of Gilbert Strang Hosted by MITOpenCourseware available at Video Lectures | Linear Algebra | Mathematics | MIT Open Course Ware.

12. Klein, P. N. *Coding the Matrix Linear Algebra through Applications to Computer Science,* Newtonian Press, 2013.
13. Dan Bader, David Amos, Joanna Jablonski, Fletcher Heister: *Python Basics: A Practical Introduction to Python (1st Edition)* Real Python March 2021

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- Use Python to perform computations in the modules 1 to 4 efficiently
- Transpose of a Linear Transformation (Chapter 3 Section 3.7)
- The rational and Jordan forms (Chapter 7-Sections 7.1 to 7.3)

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<table>
<tr><td>Programme</td><td colspan="4">B Sc Mathematics</td></tr>
<tr><td>Course Name</td><td colspan="4">Theory of Complex Functions</td></tr>
<tr><td>Type of Course</td><td colspan="4">Discipline Capstone Component (Advanced) – DCC</td></tr>
<tr><td>Course Code</td><td colspan="4">24SACMAT7CC402</td></tr>
<tr><td>Course Level</td><td colspan="4">400</td></tr>
<tr><td>Course Summary</td><td colspan="4">This course is designed to develop analytical skills in complex analysis and comprehensive understanding of topics in complex analysis, preparing students for further explorations. It will explore the properties of lines and half planes in the complex plane, investigate power series and their convergence, and uncover the geometric significance of spherical representations. The course will delve into the Mobius transformations, representation of complex analytic functions as power series, providing powerful tools for expanding and analyzing these functions. Cauchy's theorems, a cornerstone of complex analysis, will be studied in its various forms, revealing its profound implications for contour integration. Students will master the theory of complex integration, gaining proficiency in evaluating integrals along contours in the complex plane. The concept of the index of a closed curve, open mapping theorem and argument principle will be discussed and their implications being analyzed. These theorems provide deep insights into the behavior of analytic functions and their relationship with the complex plane.</td></tr>
<tr><td>Semester</td><td>7</td><td>Credits</td><td>4</td><td>Total Hours</td></tr>
</table>

Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4	0	0	0	**4**
Pre-requisites, if any	The field of complex numbers, Powers and roots of complex numbers, Polar form of complex numbers, Elementary functions, Basic concepts on functions of complex variables.					

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
	Upon the successful completion of the course, the student will be able to		
1	Demonstrate a comprehensive understanding of the properties of lines and half planes in the complex plane, power series of complex numbers, spherical representation and Mobius transforms	U	1, 2, 3
2	Illustrate complex analytic functions as power series expansions, recognizing the convergence properties and regions of validity of these representations.	A	1, 2
3	Analyze various versions of Cauchy's theorem and applying them to solve complex integration problems.	An	1, 2, 3, 10
4	Explain the fundamental principles of complex integration, including the definition of line integrals, the concept of residues, and the relationship between residues and contour integrals.	E	1, 2, 3
5	Evaluate the index of a closed curve and determine the types of residues (simple, pole, and essential singularities) that can occur within a given contour.	E	1, 2
6	Interpret open mapping theorem and the argument principle to gain insights into the behaviour of holomorphic functions and their mappings.	E	1, 2
7	Develop strong analytical skills in complex analysis, laying the foundation for further exploration of advanced topics in complex analysis and related fields.	S	1, 2, 3, 9, 10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	CO No.	Hours
1	1.1	Lines and half planes in the complex plane	1	15
	1.2	Extended Plane and its Spherical representation	1	
	1.3	Power Series	1	
	1.4	Analytic functions	2	
	1.5	Analytic functions as mappings. Mobius Transformations	1	
	Text 1: Chapter 1 – Sections: 5 & 6; Chapter 3 – Sections: 1 to 3			
2	2.1	Riemann - Stieltjes integrals	4	15
	2.2	Power series representation of analytic functions	2	
	2.3	Zeros of an analytic function	2	
	2.4	The index of a closed curve	5	
	Text 1: Chapter 1 – Sections: 1 to 4 (only statements of theorem 1.4 and lemma 1.19)			
3	3.1	Cauchy's theorem and integral formula	3	15
	3.2	Homotopy version of Cauchy's theorem and simple connectivity	3, 7	
	3.3	Counting zeros, Open mapping theorem	6, 7	
	3.4	Goursat theorem	3, 7	
	Text 1: Chapter 4 – Sections: 5 to 8 (only statement of third version of Cauchy's theorem)			

4	4.1	Classification of singularities	5	**15**
	4.2	Residues	4, 5	
	4.3	**Argument Principle**	6, 7	
	Text 1: Chapter 5 – Sections: 1 to 3			
5	**Teacher Specific Contents** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)**		
	Lecture methods Student Lectures on appropriate sections Activity based Tutorials/Practical Software based visualisation of concepts		
Assessment Types	**MODE OF ASSESSMENT**		
	A	**Continuous Comprehensive Assessment (CCA) [30 marks]**	
		Components	**Mark Distribution**
		Module Test- I	5 Marks
		Module Test- II	5 Marks
		Module Test- III	5 Marks
		Module Test- IV	5 Marks
		Assignment/Seminar	5 Marks
		Quiz/Viva voce	5 Marks

	B	**End Semester Evaluation (ESE)**				
		Question Pattern [Maximum Time 2 Hours, Maximum Marks 70]				
		Module	Part A	Part B	Part C	Total
			1 Mark (MCQ)	**5 Marks**	**10 Marks**	
		I	5	2	1	**8**
		II	5	2	1	**8**
		III	5	2	1	**8**
		IV	5	2	1	**8**
		Total no of questions	**20**	**8**	**4**	**32**
		Number of questions to be answered	**20**	**6**	**2**	**28**
		Total Marks	**20**	**30**	**20**	**70**

TEXT BOOK:

1. Conway, John B. *Functions of one complex variable, 2nd Edition.* Springer, 1978.

SUGGESTED READINGS:

3. Lars V. Ahlfors, *Complex Analysis, Third edition*, McGraw Hill Internationals, 1979
4. Gamelin, Theodore. *Complex analysis*. Springer Science & Business Media, 2003.
5. Priestley, H. A. *Introduction to Complex Analysis*. OUP Oxford, 2003.
6. Mathews, John, and Russell Howell. *Complex analysis for mathematics and engineering*. Jones & Bartlett Publishers, 2012.
7. Cartan, Henri. *Elementary theory of analytic functions of one or several complex variables.* Courier Corporation, 1995.
8. Lang, Serge. *Complex analysis*. Vol. 103. Springer Science & Business Media, 2013.

ADVANCED READINGS:

1. Asmar, Nakhlé H., and Loukas Grafakos. *Complex analysis with applications*. Berlin: Springer, 2018.
2. Nevanlinna, Rolf, and Veikko Paatero. *Introduction to complex analysis*. Vol. 310. American Mathematical Society, 2007.

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- Study the Group structure of Mobius Transformations.
- Proof of Theorem 1.4 and Lemma 1.19 in Chapter 4 of Text 1
- Third version of Cauchy's Theorem
- Problems and applications of residues and Residue Theorem
- Discussion on latest research areas in Complex Analysis

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<table>
<tr><td>Programme</td><td colspan="6">B Sc Mathematics</td></tr>
<tr><td>Course Name</td><td colspan="6">Introduction to Metric Spaces</td></tr>
<tr><td>Type of Course</td><td colspan="6">Discipline Capstone Component (Advanced) – DCC</td></tr>
<tr><td>Course Code</td><td colspan="6">24SACMAT7CC403</td></tr>
<tr><td>Course Level</td><td colspan="6">400</td></tr>
<tr><td>Course Summary</td><td colspan="6">An introduction to fundamental concepts in Metric Space and generalization of continuity , connectedness, smallness conditions to metric spaces</td></tr>
<tr><td>Semester</td><td>7</td><td colspan="3">Credits</td><td>4</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Others</td></tr>
<tr><td>4</td><td>0</td><td>0</td><td>0</td><td>4</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="6">Set and Functions, Fundamentals of Analysis</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
	Upon the successful completion of the course, the student will be able to		
1	Visualize the concept of distance as a mathematical function in various spaces	A, S, I, Ap	1, 2, 3, 4, 10
2	Develop their abstract thinking skills.	A, C, S, I, Ap	1, 2, 4,10
3	Define and Illustrate the concept of metric space and its	K, U, S, Ap	1, 3, 4,

	properties		10
4	Explain the concept of continuity connectedness and compactness	K, U,S	1, 3, 4, 10
5	Explain the fundamental concepts of modern analysis and generalization to arbitrary sets.	K, A, C	1, 2, 3, 4, 10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	CO No.	Hours
1	1.1	Inequalities	1	15
	1.2	Metric Spaces	1	
	1.3	Sequences in metric spaces	1,2	
	1.4	Cauchy Sequence (Definitions, Examples and statements only)	2,3	
	1.5	Completion in Metric Spaces (Proof of Theorem 1.5.3 is excluded)	2,3	
	Text 1: Chapter 1 – Sections: 1.1 to 1.5			
2	2.1	Open and Closed Sets	3	15
	2.2	Relativization and subspaces	3,5	
	2.3	Countability Axioms and Separability	3,5	
	Text 1: Chapter 2 – Sections: 2.1 to 2.3			

3	3.1	Continuous Mapping	**4**	**15**
	3.2	Uniform continuity	2 ,4	
	3.3	Homeomorphism , Equivalent metrics and Isometry	2,4	
	Text 1: Chapter 3 – Sections: 3.1, 3.4 & 3.5			
4	4.1	Connectedness	4,5	**15**
	4.2	Bounded sets and compactness	4, 5	
	4.3	Other characterisation of compactness	4,5	
	4.4	Continuous functions on compact spaces	4,5	
	Text 1: Chapter 4 – Sections: 4.1; Chapter 5 - Sections: 5.1 to 5.3			
5	**Teacher Specific Contents** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)**		
	Chalk and Talk, Group Discussion, Seminar, Interactive Sessions, Tutorials, Assignment, Quiz		
	MODE OF ASSESSMENT		
	A	**Continuous Comprehensive Assessment (CCA) [30 marks]**	
		Components	**Mark Distribution**
		Module Test- I	**5** Marks

Assessment Types		Module Test- II	5 Marks
		Module Test- III	5 Marks
		Module Test- IV	5 Marks
		Assignment/Seminar	5 Marks
		Quiz/Viva voce	5 Marks
	B	**End Semester Evaluation (ESE)**	
		Question Pattern [Maximum Time 2 Hours, Maximum Marks 70]	

Module	Part A **1 Mark (MCQ)**	Part B **5 Marks**	Part C **10 Marks**	Total
I	5	2	1	**8**
II	5	2	1	**8**
III	5	2	1	**8**
IV	5	2	1	**8**
Total no of questions	**20**	**8**	**4**	**32**
Number of questions to be answered	**20**	**6**	**2**	**28**
Total Marks	**20**	**30**	**20**	**70**

TEXT BOOK:

1. Satish Shirali, Harikrishnan L Vasudeva, Matric Spaces, Springer – Verlag London Limited 2006.

SUGGESTED READINGS:

1. Simmons, George F. *Introduction to Topology and Modern Analysis*, McGraw-Hill Book Company, 1963.
2. Joshi, K.D. *Introduction to General Topology*, Wiley Eastern Ltd, 1984.

ADVANCED READING:

1. Dugundji. Topology, Universal Book Stall, New Delhi, 1989.

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- Related Exercise problems in 1.6, 2.5, 3.8
- Proofs of all propositions in section 1.4
- Section 4.2: Local connectedness

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Programme	**B Sc Mathematics**					
Course Name	**Advanced Theory of Groups and Rings**					
Type of Course	**Discipline Capstone Elective (Advanced) – DCE**					
Course Code	**24SACMAT7CE401**					
Course Level	**400**					
Course Summary	The objective of the course is to introduce advanced concepts in groups and rings. The first module includes direct products, classification of finitely generated abelian groups, factor groups and homomorphisms, normal subgroups and inner automorphisms. The second module covers computations of factor groups, simple groups, group actions and application of G-sets to finite groups. The third module includes isomorphism theorems, Sylow theorems and its applications. The fourth module contains homomorphism, factor rings and concepts on ideals.					
Semester	7	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4	0	0	0	4
Pre-requisites, if any	Fundamentals of Groups and Rings					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
	Upon the successful completion of the course, the student will be able to		
1	Understand and construct direct products of groups and analyse the structure of finitely generated abelian groups	E	1,2,3
2	Comprehend the concepts of normal subgroups, factor groups and simple groups, identify and apply the properties of factor groups and homomorphisms,	A	1,2,3,4

	compute factor groups and analyse their properties		
3	Understand group action on a set, construct examples of G-sets and orbits and apply the results on G-sets to the study of finite groups	An	1,2,3,10
4	Comprehending Sylow theorems, students will apply the Sylow theory to classify groups of different orders.	E	1,2,4
5	Analysing homomorphisms, factor rings, prime and maximal ideals.	An	1,2,3
***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)**			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course Description	CO No:	Hours
1	1.1	Direct Products	1	**17**
	1.2	The structure of finitely Generated Abelian groups	1	
	1.3	Applications	1	
	1.4	Factor groups	2	
	1.5	Homomorphisms and factor groups	2	
	1.6	Normal subgroups and inner automorphisms	2	
	Text 1: Sections: 9 & 12			
2	2.1	Factor group computations and Simple groups	2	**17**
	2.2	Center and Commutator subgroups. Statement of Theorem 13.17.	2	
	2.3	Group action on a set: The notion of a group action	3	
	2.4	Isotropy subgroups, Orbits	3	
	2.5	Application of G-sets to finite groups	3	
	Text 1: Sections: 13 & 14			

3	3.1	Isomorphism theorems	2	**14**
	3.2	Sylow theorems	4	
	3.3	Applications of the Sylow theorems	4	
	Text 1: Sections: 16 & 17			
4	4.1	Factor rings	5	**12**
	4.2	Homomorphisms, Properties of homomorphisms	5	
	4.3	Fundamental homomorphism theorem (for rings)	5	
	4.4	Prime and maximal ideals	5	
	4.5	Prime Fields	5	
	Text 1: Sections: 30 & 31.1 to 31.20			
5	**Teacher Specific Contents** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**			

Practicum
• Practicum is designed to provide supervised practical application of theoretical knowledge and skills. • Its purpose is to encourage creativity and develop Problem solving skills. • The practicum component is to be done in the classroom under the strict guidance of the teachers. • A minimum of 30 problems is to be solved, and a handwritten copy of the solutions should be kept in the department.

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)**		
	Lectures, Tutorials, Interactive Sessions, Blended Learning		
	MODE OF ASSESSMENT		
	A	**Continuous Comprehensive Assessment (CCA) [30 marks]**	
		Components	**Mark Distribution**
		Module Test- I	**5** Marks

Assessment Types		Module Test- II	**5** Marks			
		Module Test- III	**5** Marks			
		Module Test- IV	**5** Marks			
		Assignment/Seminar	**5** Marks			
		Quiz/Viva voce	**5** Marks			
	B	**End Semester Evaluation (ESE)**				
		Question Pattern [Maximum Time 2 Hours, Maximum Marks 70]				
		Module	Part A **1 Mark (MCQ)**	Part B **5 Marks**	Part C **10 Marks**	Total
		I	5	2	1	**8**
		II	5	2	1	**8**
		III	5	2	1	**8**
		IV	5	2	1	**8**
		Total no of questions	**20**	**8**	**4**	**32**
		Number of questions to be answered	**20**	**6**	**2**	**28**
		Total Marks	**20**	**30**	**20**	**70**

TEXT BOOK:

1. Fraleigh, John B., and Neal E. Brand. *A First Course in Abstract Algebra* 8th ed, Pearson Education, 2021

SUGGESTED READINGS:

1. Dummit, David S., and Richard M. Foote. *Abstract Algebra. 3rd ed.* Wiley, 2003.
2. Artin, M. *Algebra. 2nd ed., Pearson Education, 2017.*
3. Herstein, I. N. *Topics in Algebra*, 2nd *Edition, John Wiley and Sons, 2010*
4. Gallian , Joseph A, *Contemporary Abstract Algebra, 10th edition* ,Cengage 2015.
5. Musili , C. *Introduction to Rings and Modules*, 2nd revised Edition, Narosa ,1997.
6. Hungerford, Thomas W, *Algebra*, Springer,2011.

ADVANCED READINGS:

1. Hungerford, Thomas.W., Algebra, 4th Print 2003 Edition.
2. Lang, Serge, Algebra, 4th Print 2005 Edition

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- Proving An is simple for $n \geq 5$.
- Applications of G-sets to counting. Burnside's Theorem (Section 15 of Text 1)

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Programme	**B Sc Mathematics**					
Course Name	**Real Analysis**					
Type of Course	**Discipline Capstone Elective (Advanced) – DCE**					
Course Code	**24SACMAT7CE402**					
Course Level	**400**					
Course Summary	This course covers essential topics in mathematical analysis, including functions of bounded variation and rectifiable curves, the Riemann-Stieltjes integral, sequence and series of functions. Students will explore the Riemann-Stieltjes integrals. Its applications to vector-valued functions will be addressed, along with discussions on uniform convergence, integration, and differentiation in the context of sequences and series of functions. The course concludes with an examination of equicontinuous families, the Weierstrass theorem, and the power series.					
Semester	7	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4	0	0	0	4
Pre-requisites, if any	Fundamentals of Mathematical Analysis					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
	Upon the successful completion of the course, the student will be able to		
1	Understand and analyses functions of bounded variations	U, An	1, 2, 3

	and its properties.		
2	To analyze and parametrize curves, calculate arc lengths, and apply additive and continuity properties and fostering problem-solving skills in practical mathematical scenarios.	An	1,2,3,10
3	To understand the Riemann-Stieltjes integral	U, An	1, 2, 3
4	To analyse the properties of Riemann-Stieltjes integral	An	1,2,3,10
5	To understand and analyse the concept of uniform convergence and its properties.	U, An	1,2,3,10
6	To understand Equicontinuous families of functions	U	1,2,3,10
7	To study Weierstrass theorem.	U, An	1,2,3
8	To understand power series	U	1,2,3,10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	CO No.	Hours
1	1.1	Introduction, properties of monotonic functions, functions of bounded variation	1	15
	1.2	Total variation, additive property of total variation, total variation on (a, x) as a function of x.	1	
	1.3	Functions of bounded variation expressed as the difference of increasing functions, continuous functions of bounded variation.	1	
	1.4	Curves and paths, rectifiable path and arc length	2	
	1.5	Additive and continuity properties of arc length.	2	
	Text 1: Chapter 6 - Sections: 6.1 to 6.11.			

2	2.1	Definition and existence of the integral	3	**15**
	2.2	Properties of the integral	4	
	2.3	Integration and differentiation.	4	
	2.4	Integration of vector valued functions.	4	
	Text 1: Chapter 6 - Sections: 6.12 to 6.25			
3	3.1	Sequence and series of functions - Discussion of main problem.	5	**15**
	3.2	Uniform convergence.	5	
	3.3	Uniform convergence and Continuity.	5	
	3.4	Uniform convergence and Integration.	5	
	3.5	Uniform convergence and Differentiation.	5	
	Text 2: Chapter 7 - Sections: 7.1 to 7.18.			
4	4.1	Equicontinuous families of functions.	6	**15**
	4.2	The Weierstrass theorem	7	
	4.3	Power series	8	
	Text 2: Chapter 7 - Sections: 7.19 to 7.27; Chapter 8 – sections: 8.1 to 8.5.			

5	**Teacher Specific Contents** (*This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture, Tutorial and Activity oriented

Assessment Types

MODE OF ASSESSMENT

A — Continuous Comprehensive Assessment (CCA) [30 marks]

Components	**Mark Distribution**
Module Test- I	**5** Marks
Module Test- II	**5** Marks
Module Test- III	**5** Marks
Module Test- IV	**5** Marks
Assignment/Seminar	**5** Marks
Quiz/Viva voce	**5** Marks

B — End Semester Evaluation (ESE)

Question Pattern
[Maximum Time 2 Hours, Maximum Marks 70]

Module	Part A **1 Mark (MCQ)**	Part B **5 Marks**	Part C **10 Marks**	Total
I	5	2	1	**8**
II	5	2	1	**8**
III	5	2	1	**8**
IV	5	2	1	**8**
Total no of questions	**20**	**8**	**4**	**32**
Number of questions to be answered	**20**	**6**	**2**	**28**
Total Marks	**20**	**30**	**20**	**70**

TEXT BOOKS:

1. Apostol, Tom M. *Mathematical analysis*. Narosa, 1974.
2. Rudin, Walter. *Principles of mathematical analysis*. Vol. 3. New York: McGraw-hill, 1976.

SUGGESTED READINGS:

1. Stein, Elias M., and Rami Shakarchi. *Real analysis: measure theory, integration, and Hilbert spaces*. Princeton University Press, 2009.
2. Abbott, Stephen. *Understanding analysis.*.springer publication, 2015.
3. Fitzpatrick, Patrick. *Advanced calculus*.Vol. 5. American Mathematical Soc., 2009.
4. Folland, Gerald B. *Real analysis: modern techniques and their applications*. Vol. 40. John Wiley & Sons, 1999.
5. Royden, H.L. *Real Analysis, 2nd edition*, Macmillan, New York.

ADVANCED READINGS:

1. Gelbaum, Bernard R., and John MH Olmsted. *Counterexamples in analysis*. Courier Corporation, 2003.
2. Carothers, Neal L. *Real analysis*. Cambridge University Press, 2000.
3. Rudin, Walter. Real and complex analysis, Mcgraw-hill international editions: Mathematics series, 1987.
4. Axler, Sheldon. *Measure, integration & real analysis*. Springer Nature, 2020.
5. Widder, David V. *Advanced calculus*. Courier Corporation, 2012.
6. Franklin, Philip. *A treatise on advanced calculus*. Courier Dover Publications, 2016.

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- Equivalence of paths, change of parameter. (*Text 1, Chapter 6 Section 6.12*)
- Linear Space of functions.
- Absolutely continuous functions and Bounded variation.
- Uniform Lipschitz condition and bounded variation.
- Prime numbers and Riemann zeta function.
- Riemann Stieljes integration of Cantor sets
- Weak form of Lebesgue's dominated convergence theorem.
- Helly's Selection Theorem.
- Space Filling Curves.
- The algebraic completeness of complex field.
- The exponential and logarithmic functions.
- The trigonometric functions.
- Algebra and its Uniform closure
- Stone's generalization of the Weierstrass theorem (Theorem)
- Fourier series.
- Gamma Functions.

Department of Mathematics
St. Albert's College (Autonomous) Ernakulam

Programme	**B Sc Mathematics**					
Course Name	**Graph Theory**					
Type of Course	**Discipline Capstone Elective (Advanced) – DCE**					
Course Code	**24SACMAT7CE403**					
Course Level	**400**					
Course Summary	This course provides a comprehensive introduction to graph theory, equipping students with the knowledge and skills to analyse and solve problems in diverse fields like computer science, biology, chemistry, sociology, operations research etc.					
Semester	7	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4	0	0	0	4
Pre-requisites, if any	Definition of a graph					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
	Upon the successful completion of the course, the student will be able to		
1	Understand basic concepts and properties of graphs.	U	1, 2, 10
2	Analyse real world problems using graph theory	An	1,2,3,10
3	Understand the theoretical approach of graph theory	U	1, 2, 10

4	Identify research problems relating to graph theory	I	1, 2, 3, 4, 6, 9, 10
5	Visualize graphs using different software.	S	1
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	CO No.	Hours
1	1.1	Introduction, Basic concepts, Sub graphs, Degrees of vertices.	1	**15**
	1.2	Paths and Connectedness.	3	
	1.3	Operations on graphs.	3	
	1.4	Directed Graphs: Introduction, basic concepts.	3	
	1.5	Tournaments.	3	
	Text 1: Chapter 1 – Sections: 1.1 to 1.5, 1.8; Chapter 2 – Sections: 2.1 to 2.3			
2	2.1	Connectivity: Introduction, Vertex cuts and edge cuts	1, 3	**15**
	2.2	Connectivity and edge connectivity.	3	
	2.3	Blocks.	1	
	Text 1: Chapter 1 – Sections: 3.1 to 3.3, 3.4.1 & 3.4.2			
3	3.1	Trees: Introduction, Definition, characterization and simple properties.	1, 3	**15**

	3.2	Centres and Centroids.	1, 3	
	3.3	Independent Sets.	1, 2	
	3.4	Eulerian and Hamiltonian Graphs: Introduction, Eulerian graphs.	1, 2, 3	
	3.5	Hamiltonian Graphs, Closure of graphs.	1, 2, 3	
	Text 1: Chapter 4 – Sections: 4.1 to 4.3; Chapter 5 – Sections: 5.1, 5.2; Chapter 6 – sections: 6.1 to 6.3			
4	4.1	Graph Colorings: Introduction, Vertex Coloring.	1, 2, 3, 4	**15**
	4.2	Planarity: Introduction, Planar and Nonplanar Graphs.	1, 2, 3	
	4.3	Euler Formula and its consequences, K5 and K3, 3 are Non-planar Graphs.	2, 3	
	Text 1: Chapter 7 – Sections: 7.1 to 7.2.5; Chapter 8 – Sections: 8.1 to 8.4			
5	**Teacher Specific Contents** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)**		
	Direct Instruction, Brainstorming Approach, Interactive instruction, Group Discussion, Presentation by individual student/ group representatives.		
	MODE OF ASSESSMENT		
	A	**Continuous Comprehensive Assessment (CCA) [30 marks]**	
		Components	**Mark Distribution**
		Module Test- I	**5** Marks

Assessment Types		Module Test- II		**5** Marks		
		Module Test- III		**5** Marks		
		Module Test- IV		**5** Marks		
		Assignment/Seminar		**5** Marks		
		Quiz/Viva voce		**5** Marks		
	B	**End Semester Evaluation (ESE)**				
		Question Pattern [Maximum Time 2 Hours, Maximum Marks 70]				
		Module	Part A **1 Mark (MCQ)**	Part B **5 Marks**	Part C **10 Marks**	Total
		I	5	2	1	**8**
		II	5	2	1	**8**
		III	5	2	1	**8**
		IV	5	2	1	**8**
		Total no of questions	**20**	**8**	**4**	**32**
		Number of questions to be answered	**20**	**6**	**2**	**28**
		Total Marks	**20**	**30**	**20**	**70**

TEXT BOOK:

1. Balakrishnan, R., and Ranganathan, K. A *Textbook of Graph Theory*. Second edition, Germany Springer New York, 2012.

SUGGESTED READINGS:

1. Chartrand, Gary, and Zhang, Ping. *Chromatic Graph Theory*. United States, CRC Press, 2019.
2. Clark, John, and Derek Allan Holton. *A First Look at Graph Theory*. World Scientific Publishing Company, 1991.
3. Rosen, Kenneth H. *Discrete Mathematics and Its Applications*. United States, McGraw-Hill Higher Education -, 2016.
4. West, Douglas Brent. *Introduction to Graph Theory*. United Kingdom, Pearson, 2018.
5. Wilson, Robin J. *Introduction to Graph Theory* UPDF EBook. United Kingdom, Pearson Education, 2015.

ADVANCED READINGS:

1. Bondy, John Adrian, and Murty, U. S. R. *Graph Theory with Applications*. United Kingdom, Macmillan, 1976.
2. Hsu, Lih-Hsing, and Lin, Cheng-Kuan. *Graph Theory and Interconnection Networks.* United States, CRC Press, 2008.
3. Haynes, Teresa W., et al. *Fundamentals of Domination in Graph*s. United States, CRC Press, 2013.
4. Biggs, Norman. *Algebraic Graph Theory*. United Kingdom, Cambridge University Press, 1993.
5. Kottarathil, Jomon, et al. *Graph Theory and Decomposition*. CRC Press, Boca Raton, USA, 2024.
6. Li, Xueliang, et al. *Graph Energy. United States,* Springer New York, 2012.
7. Bapat, Ravindra B. *Graphs and Matrices.* India, Springer London, 2014.

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- An application to Chemistry(Section 1.10),
- An application to Social Psychology (Section 1.11),
- Proof of theorem 2.3.2
- Counting the number of Spanning Trees (Section 4.4),
- Cayley's Formula (Section 4.5),
- Applications: The Connector Problem (Section 4.7.1),
- Kruskal's Algorithm
- Edge Coloring (Section 7.6)
- The Four-Color Theorem and the Heawood Five-Color Theorem (Section 8.6)
- Spectral Properties of Graphs: Chapter 11
- Visualize graphs using software like Sage Math, Python, or Wolfram Mathematica

SEMESTER VIII

Semester 8

Course Code	Title of the Course	Type of the Course	Credit	Hours/ Week	Hour Distribution /week			
					L	T	P	O
24SACMAT8CC401	Functional Analysis	Discipline Capstone Component (Advanced) – DCC	4	5	3	0	1	0
24SACMAT8CC402	Measure Theory and Integration	Discipline Capstone Component (Advanced) – DCC	4	5	3	0	1	0
24SACMAT8CE401	Basic Topology	Discipline Capstone Elective (Advanced) – DCE	4	5	3	0	1	0
24SACMAT8CE402	Field Theory	Discipline Capstone Elective (Advanced) – DCE	4	5	3	0	1	0
24SACMAT8CE403	Optimization Techniques	Discipline Capstone Elective (Advanced) – DCE	4	5	3	0	1	0
24SACMAT8PR403	Project (Research/ Honours)		12/8					

L — Lecture, T — Tutorial, P — Practical/Practicum , O — Others

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Ernakulam

<table>
<tr><td>Programme</td><td colspan="6">B Sc Mathematics</td></tr>
<tr><td>Course Name</td><td colspan="6">Functional Analysis</td></tr>
<tr><td>Type of Course</td><td colspan="6">Discipline Capstone Component (Advanced) – DCC</td></tr>
<tr><td>Course Code</td><td colspan="6">24SACMAT8CC401</td></tr>
<tr><td>Course Level</td><td colspan="6">400</td></tr>
<tr><td>Course Summary</td><td colspan="6">This is a comprehensive curriculum on vector spaces and related concepts which facilitate between Linear Algebra and Advanced Functional Analysis. It covers various aspects of normed spaces, linear operators, inner product spaces and Hilbert spaces. These chapters delve into the properties of vector spaces equipped with different structures, like norms and inner products. The concepts progress from normed spaces, linear operators and functionals to more specialized spaces like Hilbert spaces, emphasizing their properties, relationships and specific identities related to inner product spaces. The course ends with Hahn-Banach Theorem, the most important theorem connected with bounded linear operators, which is an extension theorem for linear functionals and guarantees that a normed space is richly supplied with linear functionals. The concepts and problems are intended to help the student to develop skill and intuition in Functional Analysis and its applications.</td></tr>
<tr><td>Semester</td><td>8</td><td colspan="3">Credits</td><td>4</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Others</td></tr>
<tr><td>3</td><td>0</td><td>1</td><td>0</td><td>5</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="6">Ordinary Calculus, Metric spaces, Cauchy sequences, Complete spaces, Linear Algebra of finite dimensional vector spaces.</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
	Upon the successful completion of the course, the student will be able to		
1	Analyse the additional characteristics and properties exhibited by normed spaces and comprehend how these properties influence the behaviour of elements within these spaces.	An	1,2,9
2	Evaluate the peculiarities of finite-dimensional normed spaces and explore the properties and behaviour of spaces with a finite dimension.	E	1,2
3	Analyse the behaviour and properties of linear operators and functionals in various spaces.	An	1,2
4	Evaluate the structure and properties of Inner product spaces and Hilbert spaces, emphasizing completeness and orthogonality.	E	1,2,9
5	Understand the concept of the orthogonal complements and direct sum in relation to Inner Product spaces.	U	1,2,10
6	Evaluate orthonormal sets, sequences and the series related to the sequence, and total orthonormal sets and sequences	E	1, 2, 9, 10
7	Analyse the representation of functionals on Hibert Spaces and Hilbert Adjoint Operators	An	1,2,9,10
8	Evaluate the properties of self-adjoint, Unitary and Normal operators	E	1, 2, 9, 10
9	Understand Hahn - Banach Theorem, the most important theorem in connection with bounded linear operators and its generalisation to Complex Vector spaces and normed spaces.	U	1, 2, 9, 10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	CO No.	Hours
1	1.1	Vector space	1	**20**

	1.2	Normed spaces, Banach spaces	1	
	1.3	Further properties of normed spaces. (Proof of Completion theorem (2.3-2) excluded)	1	
	1.4	Finite dimensional normed spaces and subspaces	2	
	1.5	Compactness and finite dimension.	2	
		Problems of all sections (Practicum)		
	Text 1: Chapter 2 - Sections: 2.1 to 2.5			
2	2.1	Linear operators.	3	18
	2.2	Bounded and continuous linear operators.	2, 3	
	2.3	Linear functionals (Algebraic dual, second algebraic dual and algebraic reflexivity are excluded)	3	
	2.4	Linear operators and functionals on finite dimensional spaces (Proof of theorem 2.9-3 excluded)	3	
	2.5	Normed space of operators, Dual spaces.	3	
		Problems of all Sections (Practicum)		
	Text 1: Chapter 2 - sections: 2.6, 2.7, 2.8.1 to 2.8.8, 2.9 & 2.10			
3	3.1	Inner product spaces, Hilbert spaces.	4	20
	3.2	Further properties of inner product spaces. (Proof of Completion theorem (3.2-3) excluded)	4	

	3.3	Orthogonal complements	5	
	3.4	Direct sums	5	
	3.5	Orthonormal sets and sequences	6	
	3.6	Series related to orthonormal sequences and sets (Example 3.5-1 excluded)	6	
	3.7	Total orthonormal sets and sequences (Proof of theorem 3.6-5 excluded)	6	
		Problems of 3.1, 3.2 & 3.3 (Practicum)		
	Text 1: Chapter 3 - Sections: 3.1 to 3.6			
4	4.1	Representation of Functionals on Hilbert Spaces. (Proof of Riesz representation theorem (3.8-4) excluded)	7	**17**
	4.2	Hilbert-adjoint operator.	7	
	4.3	Self-Adjoint, Unitary and Normal Operators.	8	
	4.4	Zorn's lemma.	9	
	4.5	Hahn-Banach Theorem.	9	
	4.6	Hahn-Banach Theorem for Complex Vector Spaces and Normed Spaces	9	
	Text 1: Chapter 3 - Sections: 3.8 to 3.10; Chapter 4 - Sections: 4.1 to 4.3			
5	**Teacher Specific Contents** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**			

Practicum
• Practicum is designed to provide supervised practical application of theoretical knowledge and skills. • Its purpose is to encourage creativity and develop Problem solving skills. • The practicum component is to be done in the classroom under the strict guidance of the teachers. • A minimum of 30 problems is to be solved, and a handwritten copy of the solutions should be kept in the department.

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)**					
	Lecture methods, Problem Solving Methodologies, Activity Based Tutorials/ Practical, Software Based Visualisation of Concepts					
Assessment Types	**MODE OF ASSESSMENT**					
	A	**Continuous Comprehensive Assessment (CCA) [30 marks]**				
		Components			**Mark Distribution**	
		Module Test- I			5 Marks	
		Module Test- II			5 Marks	
		Module Test- III			5 Marks	
		Module Test- IV			5 Marks	
		Assignment/Seminar			5 Marks	
		Quiz/Viva voce			5 Marks	
	B	**End Semester Evaluation (ESE)**				
		Question Pattern [Maximum Time 2 Hours, Maximum Marks 70]				
		Module	Part A **1 Mark (MCQ)**	Part B **5 Marks**	Part C **10 Marks**	Total
		I	5	2	1	**8**
		II	5	2	1	**8**
		III	5	2	1	**8**

		IV	5	2	1	**8**
		Total no of questions	**20**	**8**	**4**	**32**
		Number of questions to be answered	**20**	**6**	**2**	**28**
		Total Marks	**20**	**30**	**20**	**70**

TEXT BOOK:

1. Erwin Kreyszig, *Introductory Functional Analysis with Applications*, Wiley International publication. 1978 (Reprint 2007)

SUGGESTED READINGS:

1. Limaye, B V. *Functional Analysis*. New Age International (P) LTD, New Delhi,2004.
2. Simmons, G F. *Introduction to Topology and Modern Analysis*, Mc Graw-Hill, New York,1963.
3. Siddiqi, A H. *Functional Analysis with Applications*, Tata Mc Graw-Hill, New Delhi, 1989.
4. Walter Rudin. *Functional Analysis, Second Edition*, International Series in Pure & Applied Mathematics, Tata Mc Graw Hill, 1973.

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- Example 2.2-7
- Proof of completion theorem 2.3-2
- Canonical mapping and algebraic reflexivity (2.8)
- Example 3.1-5
- Proof of Completion theorem 3.2-3
- Example 3.5.1
- Proof of theorem 3.6-5
- Legendre, Hermite and Laguerre Polynomials (3.7)
- Proof of Riesz representation theorem 3.8-4
- Application to Bounded Linear Functionals on C[a,b] (4.4)

Department of Mathematics
St. Albert's College (Autonomous)
Ernakulam

Programme	**B. Sc. Mathematics**
Course Name	**Measure Theory and Integration**
Type of Course	**Discipline Capstone Component (Advanced) – DCC**
Course Code	**24SACMAT8CC402**
Course Level	**400**
Course Summary	This course provides a comprehensive exploration of measure theory and integration, with a primary focus on the development and applications of the Lebesgue measure and integral. The syllabus covers fundamental concepts such as Lebesgue outer measure, sigma algebra of Lebesgue measurable sets, outer and inner approximation techniques, countable additivity, and the Borel-Cantelli Lemma. Students will delve into non-measurable sets, including the Canter set and Canter Lebesgue function. The second part of the course introduces Lebesgue measurable functions and their integration. Topics include Lebesgue integration for sums, products, and compositions of functions, sequential pointwise limits, and simple approximations. Classical theorems, including Littlewood's three principles, Egoroff's theorem, and Lusin's theorem, are presented without proof to provide a practical understanding of their applications. The Lebesgue integration section covers a comparison between the Riemann and Lebesgue integrals. Students will learn to calculate the Lebesgue integral of bounded measurable functions over sets of finite measure, as well as explore the integral for measurable non-negative functions. The General Lebesgue Integral is introduced along with discussions on countable additivity and continuity of integration. The course also addresses the integration of derivatives and the differentiation of indefinite integrals. The latter part of the course extends the study to general measure spaces. Students will explore properties and constructions of measures and measurable sets. Signed measures, Hahn and Jordan decompositions, and the Caratheodory Measure induced by an outer measure are discussed. The construction of outer measures is covered, leading to advanced theorems such as the Radon-Nikodym Theorem, Lebesgue Decomposition Theorem, and Radon-Nikodym Derivative. The course concludes with a generalization of measurability concepts for functions on general measurable spaces. Students will study integration over general measure spaces, utilizing the

	Caratheodory construction of measure. The construction of product measures is introduced, and classic theorems of Fubini and Tonelli are proven. By the end of the course, students will have a comprehensive understanding of measure theory and integration, with the ability to apply these concepts in both Lebesgue and general measure spaces. The course aims to equip students with the analytical tools necessary for advanced mathematical applications and research.					
Semester	**8**	Credits			**4**	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	0	1	0	**5**
Pre-requisites, if any	Fundamentals of Mathematical Analysis					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
	Upon the successful completion of the course, the student will be able to		
1	Acquire a deep understanding of the principles behind the Lebesgue measure, including its introduction, outer measure, and the sigma algebra associated with Lebesgue measurable sets	U	1,2,3
2	Develop skills in both outer and inner approximation methods for Lebesgue measurable sets, allowing them to analyze and manipulate these sets effectively	S	1,2,9
3	Master the principles of countable additivity and continuity, fundamental for Lebesgue measure theory through theoretical understanding and practical applications,	A	1,2,9
4	Recognize and analyze non-measurable sets, including specific examples like the Cantor set, and comprehend the implications of their existence	E	1,2,9
5	Gain a theoretical understanding of Littlewood's three principles and the theorems of Egoroff and Lusin, allowing them to apply these principles in various scenarios without requiring formal proof.	An	1,2
6	Develop proficiency in integrating functions within the Lebesgue framework, including the Riemann integral, Lebesgue integral of bounded and non-negative measurable functions, and the General Lebesgue Integral.	C	1,2,3,9
7	Apply integration techniques to differentiate indefinite integrals, showcasing a practical understanding of the interplay between differentiation and integration	A	1,2,3,9,10

8	Acquire a comprehensive understanding of general measure spaces, including their properties and construction, enabling them to analyze and work with measures in a broader context.	U	1,2,10
9	Proficient in utilizing the Caratheodory construction of measure, allowing them to construct product measures and prove classic theorems such as Fubini and Tonelli in the context of general measure spaces.	S	1,2,3, 10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course Description	Hrs	CO No.
1		**Lebesgue Measure**	**20**	
	1.1	Introduction	3	1
	1.2	Lebesgue outer measure	3	1
	1.3	The algebra of Lebesgue measurable sets	3	1
	1.4	Outer and inner approximation of Lebesgue measurable sets	3	2
	1.5	Countable additivity, continuity and Borel-Cantelli Lemma	3	2, 3
		Problems (Practicum)	**5**	
	Text 1: Chapter 2 - Sections: 2.1 to 2.5			
2		**Measurable Functions**	**17**	
	2.1	Non measurable set	2	3, 4
	2.2	The Cantor set and Cantor Lebesgue function	2	3, 4

	2.3	Lebesgue Measurable Functions: Sums, products and compositions	3	5
	2.4	Sequential pointwise limits and simple approximation	2	5
	2.5	Littlewood's three principles, Egoroff's theorem, and Lusin's theorem (All theorems without proof)	3	5
		Problems (Practicum)	**5**	
	Text 1: Chapter 2 - Sections: 2.6 to 2.7, 3.1 to 3.3			
3		**Lebesgue Integration**	**20**	
	3.1	The Riemann Integral	2	6
	3.2	The Lebesgue integral of a bounded measurable function over a set of finite measure	3	6
	3.3	The Lebesgue integral of a measurable non negative function	2	6
	3 .4	The General Lebesgue Integral.	2	6
	3.5	Countable Additivity and Continuity of Integration	3	6
	3.6	Integrating Derivatives: Differentiating Indefinite Integrals	3	7
		Problems (Practicum)	5	
	Text 1: Chapter 2 - Sections: 4.1 to 4.5; Chapter 6 - Section: 6.5			
4		**General Measure spaces: Their properties and construction**	**18**	
	4.1	Measures and Measurable Sets (Theorems without proof)	4	8
	4.2	Signed Measures: The Hahn and Jordan Decompositions	3	8
	4.3	The Caratheodory Measure Induced by an Outer Measure (Propositions 5,6 and 7 Statement only)	4	9

	4.4	The Construction of Outer Measures	3	9
	4.5	The Radon-Nikodym Theorem (without proof), The Lebesgue Decomposition Theorem and Radon-Nikodym Derivative	4	8, 9
	Text 2: Chapter 17 - Sections: 17.1 to 17.4; Chapter 18 - Section: 18.4			
5	**Teacher Specific Contents** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**			

Practicum
Practicum is designed to provide supervised practical application of theoretical knowledge and skills. **I**t's purpose is to encourage creativity and develop Problem solving skills. **T**he practicum component is to be done in the classroom under the strict guidance of the teachers. **A** minimum of 30 problems is to be solved, and a handwritten copy of the solutions should be kept in the department.

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)**		
	Direct Instruction, Brainstorming Lecture, Explicit Teaching, Active Co-operative Learning		
Assessment Types	**MODE OF ASSESSMENT**		
	A	**Continuous Comprehensive Assessment (CCA) [30 marks]**	
		Components	**Mark Distribution**
		Module Test- I	5 Marks
		Module Test- II	5 Marks
		Module Test- III	5 Marks
		Module Test- IV	5 Marks
		Assignment/Seminar	5 Marks
		Quiz/Viva voce	5 Marks

	B	**End Semester Evaluation (ESE)**				
		Question Pattern [Maximum Time 2 Hours, Maximum Marks 70]				
		Module	Part A **1 Mark (MCQ)**	Part B **5 Marks**	Part C **10 Marks**	Total
		I	5	2	1	**8**
		II	5	2	1	**8**
		III	5	2	1	**8**
		IV	5	2	1	**8**
		Total no of questions	**20**	**8**	**4**	**32**
		Number of questions to be answered	**20**	**6**	**2**	**28**
		Total Marks	**20**	**30**	**20**	**70**

TEXT BOOKS:

1. Royden, H. L. , Fitzpatrick, P.M. *Real Analysis Fourth Edition, Pearson Education, 2010.*

REFERENCES:

1. . Barra, G. de. *Measure Theory and integration*, New Age International (P) Ltd., New Delhi, 1981 (Reprint 2003)
2. Halmos, P.R. *Measure Theory*, D. van Nostrand Co., 1974
3. Jain, P.K., and Gupta,V.P. *Lebesgue Measure and Integration*, New Age International (P) Ltd., New Delhi, 1986 (Reprint 2000).
4. Bartle, R.G.,*The Elements of Integration*, John Wiley & Sons, Inc New York, 1966.

SUGGESTED READINGS:

- Generalize the concepts of measurability of functions on general measurable spaces.
- Study the integration over general measure spaces
- Using Caratheodory construction of measure, construct product measures and prove the classic theorems of Fubini and Tonelli
- Prove the Radon-Nikodym Theorem

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Programme	**B Sc Mathematics**					
Course Name	**Basic Topology**					
Type of Course	**Discipline Capstone Elective(Advanced) – DCE**					
Course Code	**24SACMAT8CE401**					
Course Level	**400**					
Course Summary	Course introduces properties of topological spaces, including Compactness, Connectedness and Separation axioms					
Semester	8	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	**0**	**1**	**0**	**5**
Pre-requisites, if any	Fundamentals of Analysis and Basics of Metric spaces.					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
	Upon the successful completion of the course, the student will be able to		
1	Define and illustrate the concept of subspace and closed sets of a topological space	K, U, S, Ap	1, 2, 3,10
2	Describe the concept of neighbourhoods and interior point of a point in a topological space	U, I, Ap	1, 2, 3, 4, 10
3	Prove a selection of theorems concerning topological	U, An, Ap	1,2,4,10

	spaces, continuous functions, and quotient topologies.		
4	Define and illustrate the concepts of compact and Lindeloff Space and their properties	K, U, S, An, S, I, Ap	1,2,4,10
5	Define connectedness, separation axioms, and prove related theorems	K, U, S, An, S, I, Ap	2,3,4,10

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	CO No.	Hours
1	1.1	Definition and related concepts. Examples of topological spaces (Practicum)	1	20
	1.2	Bases and subbases	1	
	1.3	Subspaces	1	
	1.4	Closed Sets and Closure	1	
		Problems (Practicum)	1	
	Text 1: Chapter 4 – Sections: 1, 2, 3 (3.1 to 3.9), 4; Chapter 5 – Section: 1			
2	2.1	Neighbourhoods, Interior and Accumulation points	2	20
	2.2	Continuity. Related concepts (Practicum)	3	
		Problems (Practicum)	2,3	

	Text 1: Chapter 5 – Sections: 2 (2.1 to 2.10 and 2.13) & 3 (3.1 to 3.10)			
3	3.1	Making functions continuous and Quotient Spaces	3	**15**
	3.2	Smallness condition on a Space	4	
		Problems (Practicum)	3,4	
	Text 1: Chapter 5 – Sections: 4 (4.1 to 4.12); Chapter 6 – Sections: 1 (1.1 to 1.11)			
4	4.1	Connectedness	5	**20**
	4.2	Path Connectedness (Practicum)	5	
	4.3	Separation axioms	5	
		Problems (Practicum)	5	
	Text 1: Chapter 6 – Sections: 2 & 3 (3.6 to 3.8); Chapter 7 – Section: 1			
5	**Teacher Specific Contents** (This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned) **This content will be evaluated internally**			

Practicum
● Practicum is designed to provide supervised practical application of theoretical knowledge and skills. ● Its purpose is to encourage creativity and develop Problem solving skills. ● The practicum component is to be done in the classroom under the strict guidance of the teachers. ● A minimum of 30 problems is to be solved, and a handwritten copy of the solutions

should be kept in the department.

Teaching and Learning Approach	Classroom Procedure (Mode of transaction)					
	Chalk and talk, Group discussion, Seminar, Interactive sessions, Tutorials, Assignment, Quiz					
Assessment Types	**MODE OF ASSESSMENT**					
	A	**Continuous Comprehensive Assessment (CCA) [30 marks]**				
		Components			**Mark Distribution**	
		Module Test- I			**5** Marks	
		Module Test- II			**5** Marks	
		Module Test- III			**5** Marks	
		Module Test- IV			**5** Marks	
		Assignment/Seminar			**5** Marks	
		Quiz/Viva voce			**5** Marks	
	B	**End Semester Evaluation (ESE)**				
		Question Pattern [Maximum Time 2 Hours, Maximum Marks 70]				
		Module	Part A	Part B	Part C	Total
			1 Mark (MCQ)	**5 Marks**	**10 Marks**	
		I	5	2	1	**8**
		II	5	2	1	**8**
		III	5	2	1	**8**
		IV	5	2	1	**8**
		Total no of questions	**20**	**8**	**4**	**32**
		Number of questions to be answered	**20**	**6**	**2**	**28**
		Total Marks	**20**	**30**	**20**	**70**

TEXT BOOK:

1. K. D. Joshi. *Introduction to General Topology*, Third Edition, New Age International(P) Ltd, 2023.

SUGGESTED READINGS:

1. Munkres J.R, *Topology-A First Course*, Prentice Hall of India (P). Ltd., New Delhi, 2000.
2. Willard, Stephen. *General Topology*, Addison-Wesley, 2004.
3. George F Simmons, *Introduction to Topology and Modern Analysis*, McGraw-Hill Book Company, 1963.

ADVANCED READINGS:

1. Dugundji. *Topology*, Universal Book Stall, New Delhi, 1989.
2. J. Arthur Seebach, Lynn Arthur Steen, *Counter Examples in Topology*, Dover Publications, 1995

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- Study the concept of nearness relation on a set and the one-to-one correspondence between set of topologies on a set and the set of nearness relation on that set.
- Study the concept of embedding problem, extension problem and lifting problem.
- Study the concept of identification space and identification maps.
- Study the concept of local connectedness.

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<table>
<tr><td>Programme</td><td colspan="6">B Sc Mathematics</td></tr>
<tr><td>Course Name</td><td colspan="6">Field Theory</td></tr>
<tr><td>Type of Course</td><td colspan="6">Discipline Capstone Elective(Advanced) – DCE</td></tr>
<tr><td>Course Code</td><td colspan="6">24SACMAT8CE402</td></tr>
<tr><td>Course Level</td><td colspan="6">400</td></tr>
<tr><td>Course Summary</td><td colspan="6">The objective of the course is to learn more about field theory. The first module covers topics on ring of polynomials, factorization of polynomials etc. The second module covers concepts on extension fields, finite fields etc. The third module includes automorphisms of fields, splitting fields etc. Topics on separable extensions, Galois theory etc. are covered in the fourth module.</td></tr>
<tr><td>Semester</td><td>8</td><td colspan="3">Credits</td><td>4</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Tutorial</td><td>Practicum</td><td>Others</td></tr>
<tr><td>3</td><td>0</td><td>1</td><td>0</td><td>5</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="6">Concepts from Fundamentals of Groups and Rings and Advanced Theory of Groups and Rings</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
	Upon the successful completion of the course, the student will be able to		
1	Explain ring of polynomials, master polynomial factorization, and comprehend the ideal structure in F[x].	An	1, 2, 3, 10
2	Comprehend the concept of extension, distinguish the various types of extensions and analyse finite fields.	An	1, 2, 3, 10
3	Examine field automorphisms, categorize splitting fields and apply the isomorphism extension theorem.	A	1, 2, 3, 10
4	Analyse separable extensions and understand the Galois	E	1, 2, 3, 9, 10

	theorems.		
5	Analyse constructible numbers and understand the concepts of UFD, PID and Euclidean Domains	An	1, 2, 3, 4, 10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course Description	CO No:	Hours
1	1.1	Rings of polynomials, The evaluation homomorphisms	1	15
	1.2	Factorization of polynomials over a field, The division algorithm in F[x]	1	
	1.3	Irreducible polynomials, Uniqueness of factorization in F[x]	1	
	1.4	Ideal Structure in $F[x]$, Application to unique factorization in F[x]	1	
		Problems (Practicum)		
	Text 1: Sections: 27, 28 & 31 (31.21 to 31.27)			
2	2.1	Introduction to Extension fields, Algebraic and transcendental elements, The irreducible polynomial for α over F	2	20
	2.2	Simple extensions	2	
	2.3	Algebraic extensions, Algebraically closed fields and algebraic closures	2	
	2.4	Finite fields, The existence of GF(p^n)	2	
		Problems (Practicum)		
	Text 1: Sections: 39, 40 (40.1 to 40.18) & 42			
3	3.1	Introduction to Galois theory	3	20
	3.2	Conjugation isomorphism	3	
	3.3	Splitting fields, The isomorphism extension theorem	3	
	3.4	Properties of splitting fields	3	
		Problems (Practicum)		

	Text 1: Sections: 43, 44 (44.1 to 44.4, 44.5 (Statement only) & 44.6 to 44.15)			
4	4.1	Separable extensions, Characteristic p	4	**20**
	4.2	Counting Automorphisms, The primitive element theorem	**4**	
	4.3	Normal extensions	4	
	4.4	Galois Theory, The Galois theorems	4	
		Problems (Practicum)		
	Text 1: Sections 45 & 46			
5	**Teacher Specific Contents** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**			

Practicum
• Practicum is designed to provide supervised practical application of theoretical knowledge and skills. • Its purpose is to encourage creativity and develop Problem solving skills. • The practicum component is to be done in the classroom under the strict guidance of the teachers. • A minimum of 30 problems is to be solved, and a handwritten copy of the solutions should be kept in the department.

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)**		
	Direct Instruction: Explicit Teaching, Lecture Interactive Instruction: Active Co-operative Learning, Seminar Presentation by Individual Student		
	MODE OF ASSESSMENT		
	A	**Continuous Comprehensive Assessment (CCA) [30 marks]**	
		Components	**Mark Distribution**
		Module Test- I	**5** Marks

Assessment Types		Module Test- II	**5** Marks
		Module Test- III	**5** Marks
		Module Test- IV	**5** Marks
		Assignment/Seminar	**5** Marks
		Quiz/Viva voce	**5** Marks
	B	**End Semester Evaluation (ESE)**	

Question Pattern
[Maximum Time 2 Hours, Maximum Marks 70]

Module	Part A **1 Mark (MCQ)**	Part B **5 Marks**	Part C **10 Marks**	Total
I	5	2	1	**8**
II	5	2	1	**8**
III	5	2	1	**8**
IV	5	2	1	**8**
Total no of questions	**20**	**8**	**4**	**32**
Number of questions to be answered	**20**	**6**	**2**	**28**
Total Marks	**20**	**30**	**20**	**70**

TEXT BOOK:

1. Fraleigh, John B., and Neal E. Brand. *A First Course in Abstract Algebra* 8th ed, Pearson Education, 2021.

SUGGESTED READINGS:

1. Dummit, David S., and Richard M. Foote. *Abstract Algebra. 3rd ed.* Wiley, 2003.
2. Artin, M. *Algebra. 2nd ed., Pearson Education, 2017*
3. Herstein, I. N. *Topics in Algebra*, 2nd *Edition.,John Wiley and Sons, 2010*
4. Gallian , Joseph A, *Contemporary Abstract Algebra, 10th edition* ,Cengage 2021.
5. Musili , C. *Introduction to Rings and Modules*, 2nd revised Edition, Narosa, 1997.

ADVANCED READINGS:

1. Hungerford, Thomas.W., Algebra, 4th Print 2003 Edition.
2. Lang, Serge, Algebra, 4th Print 2005 Edition

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- Unique Factorization Domains, Euclidean Domains ; Understanding the concepts of Unique Factorization Domain, Principal Ideal Domain, Euclidean Domain and analysing the relationships among the three (Text 1: Sections 34, 35)
- Geometric Constructions ; Gaining a basic knowledge of constructible numbers and illustrates the impossibility of certain constructions (Doubling the cube, squaring the circle, trisecting the angle) (Text 1: Sections 41)

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<table>
<tr><td>Programme</td><td colspan="6">B Sc Mathematics</td></tr>
<tr><td>Course Name</td><td colspan="6">Optimization Techniques</td></tr>
<tr><td>Type of Course</td><td colspan="6">Discipline Capstone Elective (Advanced) - DCE</td></tr>
<tr><td>Course Code</td><td colspan="6">24SACMAT8CE403</td></tr>
<tr><td>Course Level</td><td colspan="6">400</td></tr>
<tr><td>Course Summary</td><td colspan="6">This Mathematics undergraduate course investigates linear programming methods, including simplex techniques and duality theorems. It explores challenges related to Integer Linear Programming (ILP) and Mixed Integer Linear Programming (MILP), utilizing cutting-edge approaches like cutting planes and branch-and-bound methods. The curriculum also includes fundamental concepts in graph theory, such as minimum path and spanning trees, as well as sequential activity scheduling and maximum flow problems. Furthermore, the course provides an introduction to Unconstrained Optimization, utilizing tools like Taylor's series, Fibonacci, and Golden Section searches. Constrained Optimization is also covered, incorporating topics such as gradient projection and Lagrange multipliers.</td></tr>
<tr><td>Semester</td><td>8</td><td colspan="3">Credits</td><td>4</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Others</td></tr>
<tr><td>3</td><td>0</td><td>1</td><td>0</td><td>5</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="6">Linear Programming Problem, Formation of an LPP. Optimal solution</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No:	Expected Course Outcome	Learning Domains*	PO No:
	Upon the successful completion of the course, the student will be able to		

1	Apply graphical method to solve LP problems, mastering simplex tableau and duality principles for solving LP problems.	A	1, 2
2	Students master ILP, MILP problems, cutting plane, and Branch-and-Bound methods, enhancing problem-solving and optimization skills	An	1, 2
3	Analyze graphs, solve minimum path and spanning tree problems, and optimize sequential activities with maximum flow.	An	1, 2
4	Find the solution of unconstrained optimization problems using Taylor's series, Fibonacci, Golden Section, and Hooke-Jeeves methods.	E	1,2, 3
5	Find the solution of constrained optimization problems using gradient projection, Lagrange multipliers, and constrained derivatives techniques.	E	1, 2, 3
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course Description	CO NO:	Hours
1		**Linear Programming**		**20**
	1.1	LP in two-dimensional space and problems, Statement of General LP problems, Definitions of FS, BS, BFS and OS, Simplex tableau and problems.	1	
	1.2	Definition of Artificial Variable and Big-M Method, Meaning of Degeneracy in LP Problems	1	
	1.3	Duality in LP Problems, Duality Theorems (statements only), Dual Simplex Method	1	
		Problems (Practicum)	1	
	Text 1: Chapter 3 – Sections: 3.2, 3.3, Definitions in Sections 3.4 to 3.7, 3.12 to 3.14, 3.17, 3.18 & 3.20			
2		**Integer Programming**		**15**
	2.1	General ILP and MILP Problem	2	
	2.2	Cutting Plane Method	**2**	

	2.3	Branch and Bound Method	**2**	
		Problems (Practicum)	**2**	
	Text 1: Chapter 6 – Sections: 6.3, 6.5, 6.6 & 6.8			
3		**Flow in Networks**		
	3.1	Graphs: Definition and Notations	3	**15**
	3.2	Minimum Path Problem, Spanning Tree of Minimum Length.	3	
	3.3	Scheduling of Sequential Activities, Maximum Flow Problem.	3	
		Problems (Practicum)	3	
	Text 1: Chapter 5 – Sections: 5.2 to 5.7			
4		**Non Linear Programming**		
	4.1	Taylor's Series Expansions Necessary and Sufficient Condition	4	**25**
	4.2	Fibonacci and Golden Section Search	4	
	4.3	Hooke and Jeeves Search	4	
	4.4	Gradient Projection	5	
	4.5	Lagrange Multipliers	5	
	4.6	Equality Constrained Optimization: Constrained Derivatives	5	
		Problems (Practicum)	4, 5	
	Text 1: Chapter 11 – Sections: 11.2 to 11.7			
5	**Teacher Specific Contents** *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**			

Practicum
• Practicum is designed to provide supervised practical application of theoretical knowledge and skills. • Its purpose is to encourage creativity and develop Problem solving skills.

- The practicum component is to be done in the classroom under the strict guidance of the teachers.
- A minimum of 30 problems is to be solved, and a handwritten copy of the solutions should be kept in the department.

<table>
<tr><td rowspan="2">Teaching and Learning Approach</td><td colspan="6">Classroom Procedure (Mode of transaction)</td></tr>
<tr><td colspan="6">Direct Instruction: Explicit Teaching and E-learning. Interactive instruction: Engage in collaborative learning through active participation, seminars, group assignments, group discussions, and presentations by individual students or group representatives</td></tr>
<tr><td rowspan="19">Assessment Types</td><td colspan="6">MODE OF ASSESSMENT</td></tr>
<tr><td>A</td><td colspan="5">Continuous Comprehensive Assessment (CCA) [30 marks]</td></tr>
<tr><td rowspan="7"></td><td colspan="3">Components</td><td colspan="2">Mark Distribution</td></tr>
<tr><td colspan="3">Module Test- I</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test- II</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test- III</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Module Test- IV</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Assignment/Seminar</td><td colspan="2">5 Marks</td></tr>
<tr><td colspan="3">Quiz/Viva voce</td><td colspan="2">5 Marks</td></tr>
<tr><td>B</td><td colspan="5">End Semester Evaluation (ESE)</td></tr>
<tr><td rowspan="7"></td><td colspan="5">Question Pattern
[Maximum Time 2 Hours, Maximum Marks 70]</td></tr>
<tr><td rowspan="2">Module</td><td>Part A</td><td>Part B</td><td>Part C</td><td rowspan="2">Total</td></tr>
<tr><td>1 Mark (MCQ)</td><td>5 Marks</td><td>10 Marks</td></tr>
<tr><td>I</td><td>5</td><td>2</td><td>1</td><td>8</td></tr>
<tr><td>II</td><td>5</td><td>2</td><td>1</td><td>8</td></tr>
<tr><td>III</td><td>5</td><td>2</td><td>1</td><td>8</td></tr>
<tr><td>IV</td><td>5</td><td>2</td><td>1</td><td>8</td></tr>
</table>

		Total no of questions	**20**	**8**	**4**	**32**
		Number of questions to be answered	**20**	**6**	**2**	**28**
		Total Marks	**20**	**30**	**20**	**70**

TEXT BOOKS:

1. Mittal, K. V. and Mohan, C. *Optimization Methods in Operations Research and Systems Analysis*; *5th Edition*, New Age Publishers, 2020.
2. Ravindran, Philips, Solberg. *Operations Research Principles and Practice*; *2nd Edition*, Wiley India Publishers, 2012.

SUGGESTED READINGS:

1. Swarup, K. Gupta , P. K., and Man Mohan, *Operations Research*. S. Chand and Sons Publishers, 2010.
2. Sharma , S. D. *Operations Research Theory, Methods And Applications*;, Kedar Nath Ram Nath Publishers, 2014.

ADVANCED READING:

1. Taha, A. H. Operations Research: An Introduction. Pearson Publishers, 2012.

SOME SUGGESTIONS FOR TEACHER SPECIFIC CONTENTS:

- Organize interactive discussions where students can explore the conceptual foundations of duality in linear programming. Encourage them to discuss real-world applications and implications of duality theorems. Challenge students to delve into the proofs of duality theorems. This can be done individually or in groups. They can present their understanding of the proofs to the class or in a written format.

- Challenge students to implement the Cutting Plane Method or Branch and Bound Method for solving optimization problems. They can use programming languages like Python or MATLAB or others. Encourage them to test their implementations on various problems and analyse the results.

- Demonstrate real-world applications of minimum spanning tree problems and flow in networks. This could include applications in logistics, telecommunications, project management, and network design.

- Assign small optimization problems where students can apply the Hooke and Jeeves Search method and Gradient Projection method. These problems could encompass scenarios in engineering, finance, or operations research.

Project (24SACMATPR403)

Project and Comprehensive Viva –Voce: Students can earn a maximum of 12 credits (8th Semester)

a) The project work should be done under the supervision of a teacher of the concerned department.

b) There will be an internal assessment and an external assessment for project work.

c) Project work is evaluated based on the presentation of the student and viva voce on the project.

d) External evaluation of the project work will be done by one/two external examiners from different colleges and one internal examiner from the concerned college.

e) The final external mark of the project will be calculated by taking the average of the marks given by the two external examiners and the internal examiner.

Objectives:

- **Application of Knowledge:** Utilize theoretical and practical knowledge gained during coursework to solve real-life situations or complex problems.
- **Independent Research**: Conduct independent research, demonstrating the ability to work autonomously and think critically.
- **Critical Analysis:** Develop skills in critical analysis and synthesis of information, evaluating various sources and data.
- **Professional Preparedness:** Prepare for future academic or professional endeavors by gaining experience in a research-oriented environment.
- **Scientific Communication:** Improve scientific communication skills through the preparation of reports, presentations, and discussions of findings.

Evaluation Criteria: Total 200 marks

1. **Internal Evaluation** (60 marks):
   I. Synopsis Presentation (20 marks).
   II. Technical Skill (20 marks).
   III. Report & Overall Performance (20 marks).

2. **External Evaluation** (140 marks):

   I. Relevance of the topic (20 marks).
   II. Review of Literature (20 marks).
   III. Results and Discussion (30 marks).
   IV. Presentation (30 marks).
   V. Viva Voce (40marks).