MAR IVANIOS COLLEGE
(AUTONOMOUS)

Affiliated to the

University of Kerala
Thiruvananthapuram

Kerala

SCHEME AND SYLLABUS FOR THE

FOUR YEAR UNDERGRADUATE PROGRAMME (FYUGP)

MAJOR DISCIPLINE
MATHEMATICS (Aided)

(With effect from 2024 Admissions)

Approved by the Board of Studies in

Mathematics and Statistics

CONTENTS

PREAMBLE

National Education Policy (NEP 2020) envisions 'higher education as playing an extremely important role in promoting human as well as societal wellbeing and in developing India as envisioned in its Constitution - a democratic, just, socially conscious, cultured, and humane nation upholding liberty, equality, fraternity, and justice for all' (Section 9.1). NEP also expects higher education 'to develop good, thoughtful, well-rounded, and creative individuals, enabling an individual to study one or more specialized areas of interest at a deep level, and also develop character, ethical and Constitutional values, intellectual curiosity, scientific temper, creativity, spirit of service, and 21st century capabilities across a range of disciplines including sciences, social sciences, arts, humanities, languages, as well as professional, technical, and vocational subjects' (Section 9.1.1). Hence, more than the creation of greater opportunities for individual employment, higher education represents the key to more vibrant, socially engaged, cooperative communities and a happier, cohesive, cultured, productive, innovative, progressive, and prosperous nation. (Section 9.1.3). NEP also identifies some of the major problems currently faced by the higher education system in India (Section 9.2) and envisions a complete overhaul and re-energizing of the higher education system to overcome these challenges and thereby deliver high-quality higher education, with equity and inclusion (Section 9.3). One of the major changes which the policy proposes is moving towards a more multidisciplinary undergraduate education (Section 9.3(b)) which develops all capacities of human beings -intellectual, aesthetic, social, physical, emotional, and moral in an integrated manner (Section 11.3). In order to achieve this in its full potential, NEP visions the adjusting of the structure and lengths of degree programmes accordingly. "The undergraduate degree will be of either 3 or 4-year duration, with multiple exit options within this period, with appropriate certifications, e.g., a certificate after completing 1 year in a discipline or field including vocational and professional areas, or a diploma after 2 years of study, or a Bachelor 's degree after a 3-year programme. The 4-year multidisciplinary Bachelor's programme, however, shall be the preferred option since it allows the opportunity to experience the full range of holistic and multidisciplinary education in addition to a focus on the chosen major and minors as per the choices of the student." (Section 11.9)

In accordance with the NEP 2020, the UGC formulated a new student-centric "Curriculum
and Credit Framework for Undergraduate Programmes (CCFUP)" incorporating a flexible choice-based credit system, multidisciplinary approach, and multiple entry and exit options and establishing three Broad Pathways,

(a) 3-year UG Degree,

(b) 4-year UG Degree (Honours), and

(c) 4-year UG Degree (Honours) with Research)

Accordingly, the Kerala Higher Education Reforms Commission 2022, headed by Prof Shyam B. Menon, has recommended a comprehensive reform in the

undergraduate curriculum with the adoption of the 4-year undergraduate Programmes, which will bring undergraduate education in Kerala at par with the universities abroad. Consequently, Kerala State Curriculum Committee for Higher Education 2023 has been constituted, with Dr Suresh Das as Chairman, and they have proposed a model Kerala State Higher Education Curriculum framework for undergraduate education.

The University of Kerala has decided to introduce the Four Year Under Graduate Programmes (FYUGP) from the academic year 2024-2025 onwards in its teaching departments and all affiliated colleges, and has issued many draft documents and conducted college level awareness programmes about the same.

Mar Ivanios College, by virtue of its autonomy status, conferred in 2014 and extended in 2022, vide University Grants Commission (Conferment of Autonomous Status Upon Colleges and Measures for Maintenance of Standards in Autonomous Colleges) Regulations, 2023, has the power to review existing courses/programmes and, restructure, redesign and prescribe its own courses/programmes of study and syllabi and to formulate new courses/programmes within the nomenclature specified by UGC as per the Specification of Degrees 2014 as amended from time to time. Accordingly, the Board of Studies in Mathematics and Statistics of Mar Ivanios College (Autonomous) proposed the implementation of the FYUGP scheme with effect from 2024 admission onwards and prepared the scheme and syllabi through many of the meetings and discussions. The Academic Council of the college which met on 30th April gave discussed the proposal and syllabi in detail and approved the same to be implemented from 2024 admission onwards, subject to the final directions of the University of Kerala.

The salient features of the syllabus prepared and presented by the Board of Studies include the following:

- The curriculum is designed based on Outcome Based Education (OBE) approach.
- The curriculum follows Choice-Based Credit System (CBCS): This system allows students to select courses from a prescribed list. A specified number of credits must be earned to award the degree
- The curriculum follows the basic framework, course wise/programme-wise minimum/maximum credits set by the University of Kerala for FYUGP and abides by the basic mandatory principles of **Four Year Under Graduate Programmes (UoK-FYUGP) Regulations, 2024.**
- Serve as a bridge between academic knowledge and real-world application, promoting lifelong learning and meaningful contributions."

- Encouraging students to engage with the local community through mathematics outreach programs, tutoring initiatives, or collaborative projects with schools or community organizations.
- Incorporating elements of other disciplines like computer science, physics and economics to showcase the diverse applications and connections of mathematics
- Structuring the course around project-based learning modules where students tackle open-ended mathematical problems, fostering independence, creativity, and teamwork.
- Integrating the use of mathematical software and tools into the curriculum, such as GeoGebra, Python, and LaTeX to enhance computational skills and problem-solving abilities.
- Emphasize problem-solving skills over memorization by presenting students with challenging problems that demand critical thinking and creativity.
- Partnering with industry players to offer real-world case studies, internships, or projects, giving students practical experience and exposure to potential career paths
- prepares students for a wide range of jobs and keeps up with current trends to ensure graduates are ready for today's workforce.
- Study tours offer unique chances to delve into real-world applications of mathematical concepts, enhancing their understanding and honing practical problem-solving skills across diverse industries and research environments.
- Guide students in developing these attributes uniquely, fostering personal growth and success in various aspects of life.

Graduate Attributes and Programme Outcomes (POs):

The National Higher Education Qualification Framework (NHEQF) envisages that students on completion of a programme of study must possess and demonstrate the expected graduate profile/attributes acquired through one or more modes of learning. The graduate profile/attributes indicate the quality and feature or characteristics of the graduate of a programme of study, including learning outcomes relating to the disciplinary area(s) relating to the chosen field(s) of learning and generic learning outcomes that are expected to be acquired by a graduate on completion of the programme(s) of study. The graduate profile/attributes include capabilities that help widen the current knowledge base and skills, gain and apply new knowledge and skills, undertake future studies independently, perform well in a chosen career, and play a constructive role as a responsible citizen in the society. The graduate profile/attributes are acquired incrementally and describe a set of competencies that are transferable beyond the study of a particular subject/disciplinary area and programme contexts in which they have been developed. Graduate profile/attributes are fostered through meaningful learning experiences made available through the curriculum and learning experience, the total college/university experience, and a process of critical and reflective thinking. Mar Ivanios College (Autonomous) is fully committed to ensuring the attainment of the necessary graduation attributes by the students. The college has clearly defined its raison

de'tre, the philosophy of its existence, through the Motto "Truth Shall Liberate You" (Veritas Vos Liberabit) which refers to the ultimate enlightenment which can emerge only at the intersection of sharp intellect, sound physique, strong mind, staunch ethics, and profound spirituality. This is further made explicit through its Vision, Mission and Goals and the same expect all students who graduate from the college to:

- Have inculcated "the values of truth and charity for the protection and promotion of human dignity and of a cultural heritage, through teaching, research, and extension activities dedicated to society";
- Be co-creators of a vibrant academic community known for its innovation, intellectual rigour and social commitment;
- Be "intellectually trained, morally upright, socially committed, spiritually inspired and ecologically conscious young men and women who would be dedicated to working for the good of society, the nation and the world";
- Have acquired "global competencies and skills";
- Have inculcated a sense of harmony, equality and fraternity among youth, transcending religious, linguistic, regional or sectional diversities; and
- Have developed "scientific temper, humanism and the spirit of inquiry and reform".

Programme Outcomes are the expected student attributes achieved by a student after the student completes the FYUGP from any of the streams/pathways.

The Programme Outcomes (POs) for the FYUGP programmes across all streams and pathways, based on the above core philosophy, and in consonance with the National Higher Education Qualifications Framework (NHEQF) are given below:

By the end of the Four-Year Under-Graduate Programme, students will:

PO1	**Demonstrate the acquisition of all necessary knowledge and skills within their disciplinary/ multi-disciplinary areas of learning. These include the acquisition of:** • **comprehensive knowledge and coherent understanding of their chosen disciplinary/ interdisciplinary areas of study, their linkages with related fields, and the awareness of current trends in their chosen area of study;** • **essential knowledge for skilled work in chosen field(s), including self-employment and entrepreneurship skills;** • **proficiency in specialized areas within chosen fields of study, encompassing diverse practical skills applicable to different situations within those fields;** • **the ability to apply learned knowledge to novel situations, solve problems, and relate concepts to real-world scenarios rather than just**

	memorizing curriculum content.
PO2	**Acquire problem-solving, critical thinking, analytical reasoning skills and demonstrate creativity in their thought processes** by demonstrating the ability to: • solve different kinds of problems in familiar and non-familiar contexts both within and outside their disciplinary/ multidisciplinary areas of learning; • apply analytic thought to a body of knowledge, including the analysis and evaluation of policies, and practices, as well as evidence, arguments, claims, and beliefs; • analyse and synthesize data from a variety of sources and draw valid conclusions and support them with evidence and examples. • the ability to plan, execute and report the results of an experiment or investigation; • adhere to scientific temper and ethics in their thought process; • adopt innovative, imaginative, lateral thinking, interpersonal skills and emotional intelligence; and • incubate entrepreneurial and start-up ideas.
PO3	**Develop a profound environmental dedication by fostering ecological awareness and engaging in actions that promote sustainable development** by achieving the ability to • recognize environmental and sustainability issues, and participate in actions to promote sustainable development as well as mitigate the effects of environmental degradation, climate change, and pollution; • contribute to effective waste management, conservation of biological diversity, management of biological resources and biodiversity, forest and wildlife conservation, sustainable development and living, and the preservation of life in all forms. • participate in community-engaged services/ developmental activities and thus exemplify the ideals of community engagement and service learning and deep social commitment.
PO4	**Accomplish perfect communication, teamwork, and leadership skills, particularly in academic and professional settings, while demonstrating nuance and attention to etiquette in all communicative contexts.** This will enable them to: • listen carefully, and read texts and research documents, and present complex information with clarity and precision to different audiences; • express thoughts and ideas and communicate effectively through speech and

	writing using appropriate media; • communicate using language which is respectful of gender and minority orientations; • act together as a group or a team in the interests of a common cause and working efficiently as a member of a team; • inspire the team with a vision to achieve a stated goal, and use management skills to guide the team in the right direction.
PO5	**Acquire the necessary skills, including 'learning to learn' skills, and foster innovative ideas to improve competence and employability, keeping pace with the evolving global landscape and technological advancements** by demonstrating the ability to: • pursue 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 the workplace, including adapting to the changes in work processes in the context of the fourth industrial revolution, through knowledge/ skill development/reskilling; • work independently, identify appropriate resources required for further learning; • acquire organizational and time management skills to set self-defined goals and targets with timelines; • be a proactive life-long learner. • use ICT in a variety of learning and work situations; • access, evaluate, and use a variety of relevant information sources, and use appropriate software for analysis of data; • navigate cyberspaces by following appropriate ethical principles and cyber etiquette. • use cutting edge AI tools with equal commitment to efficiency and ethics. • think 'out of the box' and generate solutions to complex problems in unfamiliar contexts;
PO6	**Develop research-related skills including the ability to conceptualize research hypotheses/projects and adopt suitable tools and methodologies for analysis** with: • a keen sense of observation, inquiry, and capability for asking relevant/ appropriate research questions; • the ability to problematize, synthesize, and articulate issues and design research proposals; • the ability to define problems, formulate appropriate and relevant research questions, formulate hypotheses, test hypotheses using quantitative and

	qualitative data, establish hypotheses, make inferences based on the analysis and interpretation of data, and predict cause-and effect relationships; • the capacity to develop appropriate methodology and tools for data collection; • the appropriate use of statistical and other analytical tools and techniques; • the ability to plan, execute and report the results of an experiment or investigation; • the ability to acquire the understanding of basic research ethics and skills in practicing/doing ethics in the field/ in personal research work, regardless of the funding authority or the field of study
PO7	**Assimilate a sound value system, a sense of autonomy, multicultural competence, social commitment, and the spirit of inclusivity and empathy by imbibing the spirit and the holistic ethos of the 'Multi-Dimensional Ivanian' (MDI) approach.** This will enable them to: • embrace and practice constitutional, humanistic, ethical, and moral values in life, including universal human values of integrity, truth, righteous conduct, peace, love, nonviolence, scientific temper, citizenship values; • identify ethical issues related to work, follow ethical practices and be objective, unbiased, and truthful actions in all aspects of work, including avoiding unethical behaviour such as fabrication, falsification or misrepresentation of data, or committing plagiarism, and adhering to intellectual property rights; • exercise responsibility and demonstrate accountability in applying knowledge and/or skills in work and/or learning contexts appropriate for the level of the qualification, including ensuring safety and security at workplaces; • practice responsible global citizenship required for responding to contemporary global challenges, enabling learners to become aware of and understand global issues and to become active promoters of more peaceful, tolerant, inclusive, secure, and sustainable societies; • effectively engage in a multicultural group/society and interact respectfully with diverse groups; • identify with or understand the perspective, experiences, or points of view and emotions of another individual or group. • demonstrate gender sensitivity and adopt a gender-neutral approach, as also empathy for the less advantaged and the differently-abled including those with learning disabilities; • demonstrate proficiency in arts/ sports/ games, physical, mental and emotional fitness, entrepreneurial /organizational /pubic speaking/environmental/ community-oriented areas by actively participating

	in the wide range of co-curricular activities that are available to the students of Mar Ivanios College.

Programme Specific Outcomes (PSOs)

In conformity with the POs, the Programme Specific Outcomes (PSOs) of the Major in Mathematics are drafted as given below:

On successful completion of the Four-Year Under-Graduate Programme with Mathematics major, students will be able to:

PSO 1	**Understand the foundational principles of mathematics in order to analyse, interpret and draw inferences from mathematical statements and data using the principles of mathematical logic and effectively communicate mathematical ideas through various means.**
PSO 2	Discuss and illustrate the core mathematical concepts contained in various branches of mathematics like analysis, algebra, discrete mathematics, probability theory and earn proficiency in advanced mathematical applications through differential equations, linear algebra, operations research, graph theory, number theory, etc.
PSO 3	Apply various mathematical principles and methods to develop proficiency in problem-solving skills with regard to real-world situations in diverse fields and build critical and analytical thinking capacity and skills through mathematical inquiry and exploration.
PSO 4	Engage with current trends and developments in diverse research and applications in mathematics in order to acquire the capacity for independent learning and research and acquire skills for ongoing self-directed study and professional development in mathematics, and embrace opportunities for intellectual growth and exploration beyond the classroom.
PSO5	Identify the diverse cultural perspectives and experiences within the mathematical community and society and improve collaboration and teamwork skills through group exercises, discussions, problem-solving activities, lab works, projects, mathematical outreach activities, etc.
PSO6	Develop expertise and skills in the use of various mathematical software and computational tools and applying them in different fields and disciplines of knowledge.
PSO7	Practise self-discipline and persistence in life through focused mathematical pursuits, overcoming challenges and setbacks through perseverance, resilience, and mastery.
PSO8	Formulate ethical awareness and responsibility in the use and application of mathematical knowledge for sustainable development and proficiency in analysing environmental data using mathematical modelling and statistical techniques.

Course and Credit Structure of FYUGP

The pathway preferably followed by the department will be Major with Minor or Major with multiple disciplines of study.

The Course and Credit Structure of FYUGP is given below:

Sem	DSC (4 Cr)	DSE (4 Cr)	AEC (3 Cr)	SEC (3 Cr)	MDC (3 Cr)	VAC (3 Cr)	Internship (credit-2)/ Project/ Additional Courses (credit-12)	Total courses	Total credits
I	A-1 B-1 C-1		AEC (Eng)-1 AEC(OL)-2		MDC-1			6	21
II	A-2 B-2 C-2		AEC (Eng)-3 AEC(OL)-4		MDC-2			6	21
III	A-2 B-2 C-2	DSE A -1			MDC (Kerala Studies)-3	VAC-1		6	22
IV	A-4 A-5	DSE A-2		SEC-1		VAC-2 VAC-3	Internship	6	21
V	A-6 A-7 A-8	DSE -3 DSE -4		SEC-2				6	23
VI	A-9 A-10 A-11	DSE -5 DSE -6		SEC-3				6	23
Total	A (11) B (3) C (3)	6	4	3	3	3	1*	36	133
EXIT OPTION AVAILABLE AND STUDENTS WILL BE AWARDED UG DEGREE WITH MAJOR IN A									
VII	A-12 A-13 B/C-4 B/C-5 B/C-6	DSE -7						6	24
VIII	MOOC courses A -14, A -15						Research Project/ Internship /Project or 03 courses - 12Cr	2+1**/3***	20
Total	A (15) B(3) C (3) B/C(3)	7	4	3	3	3	1*+1**/ 3***	44+1* + 1**/3***	177

A – Major Discipline
B/C-Minor/Multiple discipline
* - Mandatory Internship at the end of Semester 4

** - Research Project/ Internship /Project as part of Honours with Research
*** - Additional courses of 4 credits each.
Cr - Credits

- **Research group project for students exiting after UG 3 years:** Students who propose to exit after 3 Year UG programme can do a group project with an extra two credits to obtain research experience in discipline-specific areas of the program. The BoS can decide the number of students for the group and the evaluation criteria.

- Students will be able to take other pathways permissible under **University of Kerala Four Year Under Graduate Programmes (UoK-FYUGP) Regulations, 2024,** subject to the availability of courses/ faculty/infrastructure of the college.

- The Board of Studies shall prepare and publish a list of online courses at different levels before the commencement of classes in the respective semester offered in various online educational platforms recognised by the academic council of the college, which can be opted by the students for acquiring additional credits.

- **Field trip/study tour**: A study tour to places of interest in India focusing on secularism and oneness promotes intercultural understanding, tolerance, and the appreciation of diversity, fostering the values of secularism and unity in a multicultural society. Field visits provide students with practical, hands-on experiences that enhance their understanding of theoretical concepts taught in the classroom. By seeing and experiencing real-world applications of what they learn, students are better equipped to grasp and retain knowledge. This engagement can lead to improved academic performance and a deeper comprehension of the subject matter. Hence, field trip/study tour will be part of the 3 Year/4 Year UG Programme majoring in Mathematics offered by the Department of Mathematics and Statistics, Mar Ivanios College (Autonomous). The number of days for the field trip/study tour will be decided by the Principal in consultation with the BoS and the College Council.

Course Participation/Attendance-

1. A student shall be permitted to register for the end-semester evaluation of a specific course to acquire the credits only if the student has completed 75% of the prescribed classroom activities in physical, online, or blended modes, as stipulated by the BoS, including any makeup activities as specified by the faculty of that particular course.
2. The reasons/cases of permissible authorised leave shall be specified by the college, with the approval of the Academic Council, ratified by the Governing Body.
3. The condonation facility shall be availed as per the existing University/college norms.

Assessment and Evaluation

1. The assessment of a course shall combine a Continuous Comprehensive Assessment (CCA) and an End Semester Evaluation (ESE).

2. For courses without practical/lab modules, 30% weightage shall be given for CCA and the remaining 70% of the weight shall be for the ESE.
3. CCA will have two sub-components: Formative Assessment (FA) and Summative Assessment (SA).
4. The CCA subcomponents will be given marks as per the following proportions:
   - Discipline specific summative assessment - 15% of the total
   - Course attendance (Formative) - 5 % of the total.
   - Discipline specific formative assessment - 10% of the total.
5. The details of summative and formative assessment criteria, including that of attendance, will be specified by each course coordinator at the beginning of the semester, with the approval of the respective Head of the Department/BoS Chairperson and the Principal, and will be published on the college website.
6. For courses with practical/lab modules, 40% weightage shall be given for CCA and the remaining 60% of the weight shall be for the ESE.
7. In such cases specified in the item above, the CCA subcomponents will be given marks as per the following proportions:
   - Discipline specific summative assessment - 10% of the total
   - Course attendance (Formative) - 5 % of the total.
   - Discipline specific formative assessment - 15% of the total.
   - Summative Assessment (Practical Record, Practical test, skill, etc). - 10% of the total.

The above is given in detailed tabular form as follows:

Sl. No.	Activity	Percentage(%) of the total	
		Theory Courses	Courses with practical
1.	Summative Assessment (written Test or any other discipline specific assessment tools like Open book test, Lab reports, problem-based assignments, individual or team project report, case study report, literature survey, book reviews, video/film/documentary productions, etc)	15	10
2.	Summative Assessment (Practical Record, Practical test, skill, etc)	----------	10
3.	Formative Assessment (Attendance)	5	5
4.	Formative Assessment (Class room activities, observation of skills, viva voce, quiz, interview, oral presentations, in class discussions, computerized	10	15

	adaptive testing, group tutorial work, reflection writing assignments, field study reports, self and peer assessments, service-learning activities, etc.)		
	Total	**30**	**40**

8. The Course Coordinator shall be responsible for evaluating all the components of CCA for the course in question. Any grievances regarding the same shall be submitted to the Course Coordinator within 5 days of the publication of the same on the department notice board or official class group. If the grievance is not settled at the Course Coordinator level, the student is free to appeal to the Head of the Department, within the next 3 days, who will discuss the same in the Department Level Monitoring Committee (DLMC). If still needed, students can further appeal to the College Level Monitoring Committee (CLMC) or in essential situations the University Level Monitoring Committee (ULMC) in a time period as specified by these bodies.
9. Regarding evaluation, one credit will be evaluated for 20 marks in a semester; thus, a 4-credit course will be evaluated for 80 marks, and 3-credit courses for 60 marks. However, any changes to this if brought by the University will be followed.
10. The duration of the end semester examination of a course with 4 credits will be 2 hours and the same for a course with 3 credits may be 1.5 hours/2 hours.

Mark Distribution Table

Course	Credit		Marks		Lecture			Practical		
	Lecture	Practical	Lecture	Practical	CCA (30%)		ESE (70%)	CCA (40%)		ESE (60%)
					SA (50%)	FA (50%)		SA (50%)	FA (50%)	
4 credit courses	4	0	80	0	12	12	56	0	0	0
	3	1	60	20	9	9	42	4	4	12
	2	2	40	40	6	6	28	8	8	24
	1	3	20	60	3	3	14	12	12	36
	0	4	0	80	0	0	0	16	16	48
3 credit courses	Credits		Marks		Lecture			Practical		
	Lecture	Practical	Lecture	Practical	CCA (30%)		ESE (70%)	CCA (40%)		ESE (60%)
					SA (50%)	FA (50%)		SA (50%)	FA (50%)	
	3	0	60	0	9	9	42	0	0	0
	2	1	40	20	6	6	28	4	4	12
	1	2	20	40	3	3	14	8	8	24
	0	3	0	60	0	0	0	12	12	36

Letter Grades and Grade Point

1. A mark system is followed to evaluate 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.
2. The Semester Grade Point Average (SGPA) is computed from the grades to measure the student's performance in a given semester. The SGPA is based on the current term's grades, while the Cumulative Grade Point Average (CGPA) is based on the grades in all

courses taken after joining the programme of study.

3. The weighted grade point will be mentioned in the student's final grade cards, issued by the college, based on the marks obtained.

4. **The grades and grade points will be given as per the following format:**

Letter Grade	Grade Point	Percentage of marks (X) (CCA + ESE together)	Class
O (Outstanding)	10	$X \geq 95\%$	FIRST CLASS WITH DISTINCTION
A+ (Excellent)	9	$85\% \leq X < 95\%$	
A (Very Good)	8	$75\% \leq X < 85\%$	
B+ (Good)	7	$65\% \leq X < 75\%$	FIRST CLASS
B (Above Average)	6	$55\% \leq X < 65\%$	
C (Average)	5	$45\% \leq X < 55\%$	SECOND CLASS
P* (*Pass*)	4	$35\% \leq X < 45\%$	THIRD CLASS
F (Fail)	0	$X < 35\%$	FAIL
Ab (Absent)	0		FAIL

- For a course PASS, separate minimum of 35% is needed for CCA and ESE.
- Less than 35% in either ESE or CCA is FAIL.

Computation of SGPA and CGPA

SGPA (Semester Grade Point Average) and CGPA (cumulative Grade Point Average) will be computed as follows:

1. 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 undergone by a student in the semester. That is,

$$S_j = \frac{\sum(C_{ij} \times G_{ij})}{\sum C_{ij}}$$

where S_j is the SGPA in the j^{th} semester,
C_{ij} is the number of credits for the i^{th} course in the j^{th} semester, and
G_{ij} is the the grade point scored by the student in the i^{th} course in the j^{th} semester.

2. The CGPA is also calculated in the same manner considering all the courses undergone by a student over all the semesters of a programme. That is,

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

where S_i is the SGPA in the i^{th} semester and
$\sum C_i$ is the total number of credits in the i^{th} semester.

3. The SGPA and CGPA shall be rounded to 2 decimal points and reported in the transcripts.
4. **Requirement for the successful completion of a Semester:** SGPA of 4 or above and a PASS in all the courses, that is, minimum total of 35% mark in each course (CCA + ESE), with a separate minimum of 35% mark for both CCA and ESE. Appropriate and permissible rules of rounding off numbers may be adopted as per decisions of the Academic Council.
5. **Minimum Eligibility Criteria for 4 Year UG (Honours with Research):**
    - Students satisfactorily finishing all courses up to the 6th semester in the Department, with a CGPA of 7.5/10 or equivalent to 75% marks and above, will qualify to select the Honours programme with a Research Degree during the upcoming 7th and 8th semesters.
    - A relaxation of 0.5 score, i.e., CGPA of 7/10 or an equivalent relaxation of grade, will be allowed for those who belong to SC/ST/OBC (non-creamy layer)/Differently Abled, Economically Weaker Section (EWS) and other categories as per the UGC norms from time to time

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Thiruvananthapuram

22-10-2024

List of Courses

Course Code	Course Title	Course Categor	Credits	Hour distribution per week		
				L	T	P
SEMESTER I - Academic Level 100-199						
MIUK1DSCMAT100.1	Foundations of Mathematics - I	DSC	4	4		
MIUK1DSCMAT101.1	Mathematics for Physical Sciences – I	DSC	4	4		
MIUK1DSCMAT102.1	Mathematics for Life Sciences - I	DSC	4	4		
MIUK1DSCMAT103.1	Mathematics for Social Sciences - I	DSC	4	4		
MIUK1DSCMAT104.1	Mathematical Methods for Finance - I	DSC	4	4		
MIUK1DSCMAT105.1	Calculus of one and more than one variable	DSC	4	4		
MIUK1MDCMAT106.1	Quantitative Techniques and Aptitude (Basic Mathematics for Competitive Examinations)	MDC	3	3		
SEMESTER II - Academic Level 100-199						
MIUK2DSCMAT150.1	Foundations of Mathematics - II	DSC	4	4		
MIUK2DSCMAT151.1	Mathematics for Physical Sciences – II	DSC	4	4		
MIUK2DSCMAT152.1	Mathematics for Life Sciences - II	DSC	4	4		
MIUK2DSCMAT153.1	Mathematics for Social Sciences - II	DSC	4	4		
MIUK2DSCMAT154.1	Mathematical Methods for Finance - II	DSC	4	4		
MIUK2DSCMAT155.1	Linear Algebra and Numerical Approximations	DSC	4	4		
MIUK2MDCMAT156.1	Data Interpretation and Logical Reasoning	MDC	3	3		
SEMESTER III - Academic Level 200-299						
MIUK3DSCMAT200.1	Advanced Calculus	DSC	4	4		
MIUK3DSCMAT201.1	Mathematics for Physical Sciences - III	DSC	4	4		
MIUK3DSCMAT202.1	Mathematics for Life Sciences - III	DSC	4	4		
MIUK3DSCMAT203.1	Basic Operations Research	DSC	4	4		
MIUK3DSCMAT204.1	Statistics and Optimization	DSC	4	4		
MIUK3DSEMAT205.1	Elementary Number Theory and Cryptography	DSE	4	4		
SEMESTER IV - Academic Level 200-299						
MIUK4DSCMAT250.1	Linear Algebra	DSC	4	4		
MIUK4DSCMAT251.1	Vector Calculus	DSC	4	4		
MIUK4DSEMAT252.1	Theory of Equations	DSE	4	4		

MIUK4SECMAT253.1	Python Programming and LaTeX	SEC	3	3		
MIUK4INTMAT260	Internship		2			
SEMESTER V - Academic Level 300-399						
MIUK5DSCMAT300.1	Real Analysis – I	DSC	4	4		
MIUK5DSCMAT301.1	Complex Analysis	DSC	4	4		
MIUK5DSCMAT302.1	Abstract Algebra - Group Theory	DSC	4	4		
MIUK5DSEMAT303.1	Numerical Methods	DSE	4	4		
MIUK5DSEMAT304.1	Graph Theory	DSE	4	4		
MIUK5SECMAT305.1	Data Analysis using Python	SEC	3	3		
SEMESTER VI - Academic Level 300-399						
MIUK6DSCMAT350.1	Real Analysis- II	DSC	4	4		
MIUK6DSCMAT351.1	Operations Research	DSC	4	4		
MIUK6DSCMAT352.1	Abstract Algebra - Ring Theory	DSC	4	4		
MIUK6DSEMAT353.1	Differential Equations	DSE	4	4		
MIUK6DSEMAT354.1	Integral Transforms	DSE	4	4		
MIUK6SECMAT355.1	Introduction to Machine Learning	SEC	3	3		
SEMESTER VII - Academic Level 400-499						
MIUK7DSCMAT400.1	Advanced Linear Algebra	DSC	4	4		
MIUK7DSCMAT401.1	Advanced Real Analysis	DSC	4	4		
MIUK7DSCMAT402.1	Topology	DSC	4	4		
MIUK7DSEMAT403.1	Advanced Topics in Graph Theory	DSE	4	4		
MIUK7DSEMAT404.1	Ordinary Differential Equations	DSE	4	4		
MIUK7DSEMAT405.1	Abstract Algebra – Field Theory	DSE	4	4		
MIUK7DSEMAT406.1	Measure Theory and Integration	DSE	4	4		
MIUK7DSEMAT407.1	Partial Differential Equations	DSE	4	4		
SEMESTER VIII - Academic Level 400-499						
MIUK8RPHMAT460/ MIUK8CIPMAT461	Research Project/ Internship Project		12			

SEMESTER - I

Mar Ivanios College (Autonomous)

Discipline	**MATHEMATICS**				
Course Code	MIUK1DSCMAT100.1				
Course Title	**Foundations of Mathematics - I**				
Type of Course	**DSC**				
Semester	I				
Academic level	100 – 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-	-	4
Pre-requisites	1. Properties of real numbers 2. Real valued functions 3. Basics of two-dimensional geometry 4. Ability to analyse a Mathematical problem.				
	Texts : Text 1: H Anton, I Bivens, S Davis. Calculus, 10th Edition, John Wiley& Sons. Text 2 : S R Lay. Analysis with an Introduction to Proof, 5th Edition, Pearson Education. **References :** 1. G B Thomas, R L Finney. Calculus, 9th Edition, Addison-Wesley Publishing Company 2. J Stewart. Calculus with Early Transcendental Functions, 7th				

	Edition, Cengage India Private Limited 3. Tom M. Apostol. Calculus, Volume 1, 2nd Edition, John Wiley & Sons 4. Tom M. Apostol. Calculus, Volume 2, John Wiley & Sons 5. Irving M Copi, Cark Cohen, Kenneth McMohan, Introduction to Logic (14th ed), Pearson, 2011 6. Krishna Jain, A Textbook of Logic, (5th ed), DK Print World, New Delhi, 2012.
Course Summary	The course begins by delving into fundamental concepts of functions, progressing to explore advanced properties like operations on functions, graphical representations, and the impact of transformations on graph of functions. A comprehensive examination of limits, various limit evaluation techniques, and continuity follows. Additionally, the curriculum covers an in-depth analysis of Polar coordinate systems, families of lines, rays, circles, diverse curves, and spirals. The course extends to introduce cylindrical and spherical coordinate systems. Finally, it culminates with the "Logic" module, focusing on logical connectives and the methodologies employed in mathematical proofs.

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**More on Functions of One Variable**	**15**
	1	Arithmetic operations on functions, composition of functions	1
	2	Translations, reflections, sketching and compressions	3
	3	Even and odd functions	1
	4	Families of functions	2
	5	Inverse functions	2
	6	Exponential functions	1
	7	logarithmic functions	2
	8	Inverse trigonometric functions	1
	9	Hyperbolic functions	2

	ICT tools can be used to enhance effective learning. **The topics in this module can be found in chapters 0 and 6 sections 0.2, 0.3, 0.4, 6.1, 6.7, 6.8 of text [1]**		
II	**Limits and continuity**		**15**
	10	Limits, one sided limits, two sided limits and infinite limits, vertical asymptotes	3
	11	Techniques for computing limits	3
	12	Limits at infinity for polynomials	2
	13	Rational functions and functions involving radicals	1
	14	Continuity	2
	15	Continuity of trigonometric functions	1
	16	Obtaining limits by squeezing	1
	17	Introduction to differentiation	2
	ICT tools can be used to enhance effective learning. **The topics in this module can be found in chapters 1 and 2 sections 1.1, 1.2, 1.3, 1.5, 1.6, 2.1 and 2.2 of text [1]**		
III	**Coordinate geometry**		**15**
	18	parametric equations of a curve, orientation of a curve	1
	19	expressing ordinary functions parametrically	1
	20	Polar co-ordinate systems, relationship between polar and rectangular co-ordinate systems	2
	21	graphs in the polar co-ordinate system	4
	22	families of lines, rays, circles, other curves and spirals	3
	23	coordinate system in three-dimensional space	2
	24	cylindrical and spherical coordinate system	2
	ICT tools can be used to enhance effective learning. **The topics in this module can be found in chapters 10 and 11**		

	sections 10.1, 10.2, 11.1, 11.8 of text [1]		
IV	**Mathematical Logic**		**15**
	25	Statements, Logical connectives, Truth values and truth tables, Equivalent statements	5
	26	Testing argument validity through truth tables-Tautology, Negation	3
	27	Quantifiers- universal and existential	2
	28	Techniques of Mathematical proof- Methods of Deduction-Induction-Converse-Inverse-Contrapositive-case method-direct- contradiction methods	5
	ICT tools can be used to enhance effective learning. **The topics in this module can be found in chapter 1 section 1 to 4 of text [2]**		

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Define and develop the concept of functions their operations and families of functions.	U	PSO-1,3, 4, 7, 8
CO-2	Describe geometric effect of different operations on functions and draw the appropriate graph neatly and correctly.	C	PSO-1,3, 4, 5, 6, 7, 8
CO-3	Define limit and calculate limits using different computational methods.	Ap	PSO-1,2,3, 4, 7, 8
CO-4	Translate unbroken curve into a precise mathematical formulation called continuity.	U	PSO-1,2, 3, 4, 7, 8
CO-5	Sketch curves using ICT tools.	Ap	PSO-1,5, 6, 7, 8
CO-6	Understand logical concepts, truth values of statements, and apply various techniques of proof	An	PSO-1,3, 4, 5, 7, 8

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Note: 1 or 2 COs/module

Name of the Course: Credits: 4:0:0 (Lecture: Tutorial: Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO 1	Define and develop the concept of functions their operations and families of functions	PO-1,2, 4,5, 6, 7	U	F, C	L	
CO 2	Describe geometric effect of different operations on functions and draw the appropriate graph neatly and correctly	PO-1,2, 4,5, 6, 7	C	F, C, M	L	
CO 3	Define limit and calculate limits using different computational methods	PO-1,2, 4,5, 6, 7	Ap	F, C, P	L	
CO 4	Translate unbroken curve into a precise mathematical formulation called continuity.	PO-1,2, 4,5, 6, 7	U	F,C, M	L	
CO 5	Sketch curves using ICT tools.	PO-1,2, 4,5, 6, 7	Ap	P, M	L	
CO 6	Understand logical concepts, truth values of statements, and apply various techniques of proof	PO-1,2, 4,5, 6, 7	An	F, C, P, M	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	3	-	3	2	.	-	1	1	3	3	-	1	3	1	1
CO 2	3	-	3	-	2	3	1	1	3	3	-	1	3	1	1
CO 3	3	2	3	2	-	-	1	1	3	3	-	1	3	1	1

CO 4	3	2	3	2	-	-	1	1	3	3	-	1	3	1	1
CO 5	3	-	-	-	2	3	1	1	3	3	-	1	3	1	1
CO 6	3	-	3	2	2	-	1	1	3	3	-	1	3	1	1

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5		✓		
CO 6	✓	✓		✓

Mar Ivanios College (Autonomous)

<table>
<tr><td>Discipline</td><td colspan="5">MATHEMATICS</td></tr>
<tr><td>Course Code</td><td colspan="5">MIUK1DSCMAT101.1</td></tr>
<tr><td>Course Title</td><td colspan="5">Mathematics for Physical Sciences – I</td></tr>
<tr><td>Type of Course</td><td colspan="5">DSC</td></tr>
<tr><td>Semester</td><td colspan="5">I</td></tr>
<tr><td>Academic Level</td><td colspan="5">100 – 199</td></tr>
<tr><td rowspan="2">Course Details</td><td>Credit</td><td>Lecture per week</td><td>Tutorial per week</td><td>Practical per week</td><td>Total Hours/Week</td></tr>
<tr><td>4</td><td>4 hours</td><td>-</td><td>-</td><td>4</td></tr>
<tr><td>Pre-requisites</td><td colspan="5">Concept of functions, Elementary matrix theory</td></tr>
<tr><td>Text Book</td><td colspan="5">Text:

1. Anton, I Bivens, S Davis, Calculus, 10th Edition, John Wiley & Sons.
2. Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edition, Wiley-India
References:
1. George B. Thomas, Ross L. Finney, Calculus and analytic geometry, 9th Edition, Addison-wesley publishingCompany.
2. K. F. Riley, M. P. Hobson, S. J. Bence, Mathematical Methods for Physics and Engineering, 3rd Edition, Cambridge UniversityPress.
3. Mary L. Boas, Mathematics Methods in the Physical Sciences, 3rd Edition,Wiley.</td></tr>
<tr><td>Course Summary</td><td colspan="5">The course covers a comprehensive range of topics in Differentiation and its applications. It begins with the study of functions, limits and continuity. Students learn differentiation and how they are used to differentiate various functions. Students learn different properties of functions. Application of differentiation is explained. Review of matrices are to be covered. Different types of Matrices are explained. Students learn elementary row operations and how they</td></tr>
</table>

	are used to manipulate matrices, leading to the understanding of echelon forms. Finally system of linear equations are introduced. Students should be able to solve system of liner equations. completing the course's coverage of Differentiation and its diverse applications.

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Functions and Derivatives**	**15**
	1	The module should begin with revising Functions, Limits and continuity are to be covered using Sections 1.1, 1.2 and 1.5. **ICT tools can be used to enhance effective learning.**	5
		Various techniques for differentiation discussion are to be covered using Sections 2.2 to 2.7. This portion will cover the product and quotient rules, derivatives of trigonometric functions, chain rule and implicit differentiation. **ICT tools can be used to enhance effective learning.**	10
	[The topics in this module can be found in Chapter 1; Sections 1.1 , 1.2 and 1.5 Chapter 2; Sections 2.2 to 2.7 of Text.1]		
II		**Derivatives of More Functions**	**15**
	2	Basic properties of exponential and logarithmic functions and techniques of differentiation involving these functions may be explored as in Sections 6.1 and 6.2 (avoid results on integration). **ICT tools can be used to enhance effective learning.**	5
		Derivatives of Inverse trigonometric functions are to be covered in Sections 6.5 and 6.7. Introduction and derivatives of Hyperbolic functions are to be covered in Section 6.8. **ICT tools can be used to enhance effective learning.**	10
	[The topics in this module can be found in Chapter 6; Sections 6.1, 6.2, 6.5, 6.7 and 6.8 of Text.1]		
III		**Applications of Derivatives and Partial Differentiation**	**15**

	3	Properties of functions like increase, decrease, concavity, maxima and minima has to be analyzed as in Sections 3.1 and 3.2. Absolute extrema of finite intervals are to be covered in Section 3.4. Rolle's Theorem and mean value theorem has to be discussed as in Section 3.8. **ICT tools can be used to enhance effective learning.**	8
		This module begins with a study of functions of two or more independent variables. We describe the domains, graphs and level curves of such functions as in section 13.1. A discussion about partial differentiation, without going into analytic details of continuity of partial derivatives can be conducted as in section 13.3. Discuss problem 94 of exercise set 13.3. **ICT tools can be used to enhance effective learning.**	7
	[The topics in this module can be found in Chapter 3 within Sections 3.1, 3.2, 3.4 and 3.8 and Chapter 13; Sections 13.1, 13.3 of Text]		
IV	**Matrices and Determinants**		**15**
	4	Review of Matrices are to be covered in Section 7.1. Types of Matrices like upper and lower triangular matrices, Diagonal matrix, Scalar matrix, Unit matrix, Nilpotent matrix and Idempotent matrix are to be covered in Section 7.2. Linear system, Augmented matrix, Elementary row operations, Row echelon form, Row equivalent systems and Rank are to be covered in Section 7.3. Solution of linear systems are to be covered in Section 7.5	5 10
	[The topics in this module can be found in Chapter 7, Sections 7.1, 7.2, 7.3 and 7.5 of Text2]		

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Gain an idea of functions, including limits and continuity, master the concept of Differentiation, understanding various techniques of differentiation like product rule and quotient rule.	U	PSO-1,2
CO-2	Gain an understanding of derivatives of trigonometric functions, gain proficiency in finding derivatives of	R	PSO-1,3

	different trigonometric functions, master the concept of chain rule and implicit differentiation including their calculation.		
CO-3	Understanding various functions and learning techniques of differentiation involving these functions, review inverse trigonometric functions including their derivatives, learn about hyperbolic functions, understanding derivatives of hyperbolic functions.	Ap	PSO-3,8
CO-4	Master the properties of functions, understanding important theorems in differentiation, gain the idea of partial differentiation, understanding various techniques of partial differentiation, master the concept of partial differentiation.	An	PSO-1,8
CO-5	Understanding different types of matrices, gain the concept of linear system of equations, row operations, row echelon form, computing solutions of linear system of equations.	E	PSO-1,7

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Note: 1 or 2 COs/module

Name of the Course: Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO /PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO-1	Gain an idea of functions, including limits and continuity, master the concept of Differentiation, understanding various techniques of differentiation like product rule and quotient rule.	PSO-1,2	F,C	U	F, C	**L**
CO-2	Gain an understanding of derivatives of trigonometric functions, gain proficiency in finding derivatives of different trigonometric functions, master the concept of chain rule and implicit differentiation including their calculation.	PSO-1,3	F,C	R	P	**L**
CO-3	Understanding various functions and learning techniques of differentiation involving these functions, review inverse trigonometric functions	PSO-3,8	F,C	Ap	E	**L**

	including their derivatives, learn about hyperbolic functions, understanding derivatives of hyperbolic functions.					
CO-4	Master the properties of functions, understanding important theorems in differentiation, gain the idea of partial differentiation, understanding various techniques of partial differentiation, master the concept of partial differentiation.	PSO-1,8	F,C	An	U	**L**
CO-5	Understanding different types of matrices, gain the concept of linear system of equations, row operations, row echelon form, computing solutions of linear system of equations.	PSO-1,7	F,C,P	E	R	**L**

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	**PSO2**	**PSO2**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**
CO 1	2	1	3	3	3	3	2	1	2	2	3	3	3	2	3
CO 2	3	2	2	3	3	2	3	3	1	2	2	2	3	3	2
CO 3	3	3	1	3	1	2	3	2	2	3	1	2	3	2	1
CO 4	1	3	3	3	2	3	1	3	2	1	2	3	2	1	3
CO 5	2	3	2	1	3	2	3	2	2	3	2	2	2	3	2

Correlation Levels:

Level	**Correlation**
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓			✓
CO 4		✓		✓
CO 5		✓		✓
CO 6			✓	

Mar Ivanios College (Autonomous)

Discipline	**MATHEMATICS**				
Course Code	MIUK1DSCMAT102.1				
Course Title	**Mathematics for Life Sciences - I**				
Type of Course	DSC				
Semester	I				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-	-	4
Pre-requisites	1. High School Level Basic Mathematics				
Course Summary	This course provides a comprehensive overview of fundamental mathematical concepts and their applications. Beginning with integers, rational, and real numbers, students delve into the intricacies of percentages, algebraic laws, and inequalities. Powers and fractional powers lead into quadratic equations, logarithms, and the relationship between natural and common logarithms. Introduction to sets, subsets, and set operations like union and intersection, including De Morgan's laws and Venn diagrams, lays the foundation for understanding relationships within data sets. The course progresses to cover product of sets, relations, and functions, including one-to-one and onto functions, along with polynomials and various types of functions such as periodic, exponential, logarithmic, and trigonometric functions. Sketching of elementary functions using software enhances visualization skills. Examples and discussions on convergence and divergence, infinite series, and geometric and harmonic series deepen students' understanding of				

	sequences and series. The course concludes with an introduction to standard matrices, matrix algebra, determinants, vectors in space, and their real-world applications.
Text	Edward Batschelet, *Introduction to Mathematics for Life Scientists*, Springer, 1973. Chapter 1: Sections: 1.1 – 1.11 Chapter 2: Sections: 2.1 – 2.7 Chapter 3: Sections: 3.1 – 3.6 Chapter 4: Sections: 4.1 – 4.3, 4.6 Chapter 6: Sections: 6.1 – 6.4 Chapter 14: Sections: 14.1 – 14.5
References	1. S. T. Tan, *Finite Mathematics for the Managerial, Life and Social Sciences*, 9th Edition, Cengage Learning. 2. Glenn Ledder, *Mathematics for the Life Sciences*, Springer. 3. Raina S. Robeva, James R. Kirkwood, Robin L. Davies, Leon S. Farhy, Michael L. Johnson, Boris P. Kovatchev, and Marty Straume, *An Invitation to Bio mathematics*, ELSEVIER.

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Mathematical Preliminaries**	**15**
	1	Integers, Rational numbers, Real numbers	1
	2	Percentages.	1
	3	Algebraic laws	1
	4	Inequalities	2
	5	Powers and fractional powers	1
	6	quadratic equations	1
	7	logarithm, relation between natural and common logarithm	3
	8	Introduction to sets, subsets, proper subsets	1

		power set, union, intersection, complements	1
		d'Morgn's laws	2
		Ven Diagram	1
II	**Relations and Functions**		**15**
	1	Product of sets, relations,	3
	2	functions, one to one and onto functions,	3
	3	Polynomials, Periodic functions, exponential functions, logarithmic functions, trigonometric functions, Inverse of a function**,** applications	5
	4	Sketching of elementary functions like polynomial functions, exponential functions, trigonometric functions, logarithmic functions using GeoGebra or any software (Sketching of function using software is not meant for ESE)	4
III	**Sequences and Series**		**15**
	1	Examples	1
		general term	2
		convergence and divergence	1
	2	Infinite series	2
		sum to first n terms	3
	3	geometric series	2
		harmonic series	2
		convergence	2
IV	**Matrix Algebra**		**15**
	1	Introduction	2
		Standard matrices	3
	2	Matrix Algebra	2

		Determinant	3
	3	Vectors in Space	3
	4	Applications	2

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	demonstrate a strong understanding of fundamental mathematical concepts including integers, rational numbers, real numbers, percentages, algebraic laws, and inequalities.	R	PSO: 1, 2, 3, 4, 5, 6, 7
CO-2	develop problem-solving skills through solving quadratic equations, utilizing powers and fractional powers, and applying logarithms to various scenarios.	U	PSO: 1, 2, 3, 4, 5, 6, 7
CO-3	apply set theory principles, including understanding sets, subsets, and set operations such as union, intersection, and complements, along with De Morgan's laws and Venn diagrams.	Ap	PSO: 1, 2, 3, 4, 5, 6, 7
CO-4	analyse and understand various types of functions including polynomials, periodic functions, exponential functions, logarithmic functions, and trigonometric functions. They will also grasp the concept of inverse functions and their applications.	R	PSO: 1, 2, 3, 4, 5, 6, 7
CO-5	Sketch elementary functions using software like GeoGebra, enhancing their visualization skills and understanding of function behaviour.	C	PSO: 1, 2, 3, 4, 5, 6, 7
CO-6	apply mathematical concepts learned in the course to solve real-world problems, including applications in matrix algebra, determinants, vectors in space, and various other practical	C	PSO: 1, 2, 3, 4, 5, 6, 7

	scenarios.		

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)
1	demonstrate a strong understanding of fundamental mathematical concepts including integers, rational numbers, real numbers, percentages, algebraic laws, and inequalities.	PO: 1, 2, 3, 4, 5, 6, 7 / PSO: 1, 2, 3, 4, 5, 6, 7	R	F, A, P	L
2	develop problem-solving skills through solving quadratic equations, utilizing powers and fractional powers, and applying logarithms to various scenarios.	PO: 1, 2, 3, 4, 5, 6, 7 / PSO: 1, 2, 3, 4, 5, 6, 7	U	F, C, P	L
3	apply set theory principles, including understanding sets, subsets, and set operations such as union, intersection, and complements, along with De Morgan's laws and Venn diagrams.	PO: 1, 2, 3, 4, 5, 6, 7 / PSO: 1, 2, 3, 4, 5, 6, 7	Ap	C, P	L
4	analyse and understand various types of functions including polynomials, periodic functions, exponential functions, logarithmic functions, and trigonometric functions. They will also grasp the concept of inverse functions and their applications.	PO: 1, 2, 3, 4, 5, 6, 7 / PSO: 1, 2, 3, 4, 5, 6, 7	R	C, P	L
5	Sketch elementary functions using software like GeoGebra, enhancing their visualization skills and understanding of function behaviour.	PO: 1, 2, 3, 4, 5, 6, 7 / PSO: 1, 2, 3, 4, 5, 6, 7	C	F, C, P	L
6	apply mathematical concepts learned in the course to solve real-world problems, including	PO: 1, 2, 3, 4, 5, 6, 7	C	C, P, M	L

	applications in matrix algebra, determinants, vectors in space, and various other practical scenarios.	/ PSO: 1, 2, 3, 4, 5, 6, 7			

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	3	3	2	1	1	1	2	-	1	3	1	1	1	1	1
CO 2	3	3	2	1	1	1	2	-	1	3	1	1	1	1	1
CO 3	3	3	2	1	1	1	2	-	1	3	1	1	1	1	1
CO 4	3	3	2	1	1	1	2	-	1	3	1	1	1	1	1
CO 5	3	3	2	1	1	1	2	-	1	3	1	1	1	1	1
CO 6	3	3	2	1	1	1	2	-	1	3	1	1	1	1	1

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓			✓
CO 4		✓		✓
CO 5		✓		✓
CO 6			✓	

Mar Ivanios College (Autonomous)

<table>
<tr><td>Discipline</td><td colspan="5">MATHEMATICS</td></tr>
<tr><td>Course Code</td><td colspan="5">MIUK1DSCMAT103.1</td></tr>
<tr><td>Course Title</td><td colspan="5">Mathematics for Social Sciences - I</td></tr>
<tr><td>Type of Course</td><td colspan="5">DSC</td></tr>
<tr><td>Semester</td><td colspan="5">I</td></tr>
<tr><td>Academic Level</td><td colspan="5">100 - 199</td></tr>
<tr><td rowspan="2">Course Details</td><td>Credit</td><td>Lecture per week</td><td>Tutorial per week</td><td>Practical per week</td><td>Total Hours/Week</td></tr>
<tr><td>4</td><td>3</td><td>1</td><td>-</td><td>4</td></tr>
<tr><td>Pre-requisites</td><td colspan="5">1. Equations
2. Basic arithmetical operations</td></tr>
<tr><td>Course Summary</td><td colspan="5">This course typically covers fundamental mathematical concepts like set theory, different functions, permutations and combinations and techniques essential for various business applications. It includes the manipulation of algebraic expressions, solving linear equations and inequalities, and understanding basic algebraic concepts. It also covers the matrix algebra and its applications in Business. This course is mainly intended for first semester undergraduate students with Commerce as their major discipline.</td></tr>
<tr><td>Prescribed Texts</td><td colspan="5">1.B M Aggarwal – Business Mathematics and Statistics, Ane Books Pvt Ltd, 2023.

2. D.C. Sancheti, V.K. Kapoor Business Mathematics, Sultan Chand & SonsPublications, 2006.</td></tr>
<tr><td>Reference Books</td><td colspan="5">1. "Business Mathematics" by Gary Clendenen and Stanley A. Salzman, 13th Edition, Pearson Publishers
2. "Business Mathematics" by Cheryl Cleaves, Margie Hobbs, and Jeffrey Noble, 9th Edition, Pearson Publishers</td></tr>
</table>

	3. **"Essential Mathematics for Economics and Business" by Teresa Bradley:** 2nd Edition, Wiley India Private Limited

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Set Theory, Fractions, Permutations and Combinations**	**15**
	1	Set theory: definition-Null set- Subset-Power set- Equal set-Union, Intersection [The topics to be discussed in this module can be found in Chapter 2 of Text 2]	4
	2	Fractions, adding and Subtracting fractions adding and multiplying fractions decimal and fraction conversions	5
		[The topics to be discussed in this module can be found in Chapter 2,3 of the Reference text 2]	
	3	Basic concepts of permutations and combinations- Introduction-Factorial-permutation results- Circular permutations with restrictions-Combinations with standard results	6
		[The topics to be discussed in this module can be found in Chapter 9 of the text 2]	
II		**Equations**	**15**
	4	Linear equation- simultaneous linear equations Quadratic equations, quadratic equation by factoring,	15
		[The topics to be discussed in this module can be found in Chapter 8 of text 2]	
III		**Differentiation**	**15**
	5	Functions, Limits, Continuity, derivatives, rules of differentiation, differentiation of implicit functions.	15
		[The topics to be discussed in this module can be found in Chapter 3 and Chapter 4 of text 1]	
IV		**Matrix Algebra**	**15**
	6	Matrices– Matrix operations (addition, subtraction, constant multiplication and multiplication)- Determinants-Minors and cofactors-ad joint -Inverse of a Matrix, solving linear equation	15

		with matrix using Cramer's Rule. Application of Matrices and determinants to Business	
		[The topics to be discussed in this module can be found in Chapter 1,Chapter 2 of text 1]	
		[Wherever possible, ICT enabled tools should be used]	

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the concepts of set theory, permutations and combinations, analyse and solve mathematical problems related to these concepts	U	PSO-1,2,3
CO-2	Identify and practice problems related to linear equations and quadratic equations	Ap	PSO-1,2,3,6
CO-3	Determine the concept of functions, derivatives, and evaluate the problems using the rules of differentiation	Ap	PSO-1,2,3,4
CO-4	Perform different matrix operations and solve problems using different techniques of matrices	Ap	PSO-1,2,3

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Mathematics for Commerce Credits: 4:0:0 (Lecture:Tutorial:)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1	Understand the concepts of set theory, permutations and combinations, analyse and solve	PO 1,2/PSO-1,2,3	U	F, C	L	

	mathematical problems related to these concepts					
2	Identify and practice problems related to linear equations and quadratic equations	PO 1,2/ PSO-1,2,3,6	Ap	C	L	
3	Determine the concept of functions, derivatives, and evaluate the problems using the rules of differentiation	PO 1,2/PSO-1,2,3,4	Ap	C	L	
4	Perform different matrix operations and solve problems using different techniques of matrices	PO 1,2/PSO-1,2,3	Ap	C, P	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
CO1	3	3	3	2	-	-	1	2	3	3	-	-	-	2	1
CO2	3	3	3	2	1	2	-	1	3	3	-	2	-	1	-

CO 3	3	3	3	2	1	-	-	1	3	3	-	-	-	-	1
CO 4	3	3	3	-	-	-	2	2	3	3	-	2	1	-	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4		✓		✓

Mar Ivanios College (Autonomous)

Discipline	**MATHEMATICS**				
Course Code	MIUK1DSCMAT104.1				
Course Title	**Mathematical Methods for Finance - I**				
Type of Course	DSC				
Semester	I				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4	-	-	4
Pre-requisites	1. Set Theory				
Course Summary	This course at the undergraduate level typically provides students with the mathematical tools and techniques necessary for understanding and analysing economic concepts and models. It explains the differential Calculus, application of differentiation focusing on single variable optimization and Matrix Algebra. This course is designed for first semester undergraduate level economics students.				
Prescribed Text	Knut Sydsaeter, Peter J. Hammond: *Mathematics for Economic Analysis*, Pearson, 1995.				
Reference Textbooks	1 G D Allen, Mathematical Analysis for Economics, AITBS Publishers, D-2/15. Krishnan Nagar, New Delhi 2. Taro Yamane, Mathematics for Economists, An Elementary Survey, PHI, New Delhi.				

	3. Chiang A.C. and K. Wainwright, Fundamental Methods of Mathematical Economics, 4th Edition, McGraw-Hill, New York, 2005.(cw) 4. Dowling E.T, Introduction to Mathematical Economics, 2nd Edition, Schaum's Series, McGraw- Hill, New York, 2003(ETD)

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Functions Limits Continuity**	**15**
	1	**Functions of one variable**: Introduction, Functions of one real variable, graphs, graphs of functions, linear functions.	8
	2	Limits, dash of limits, continuity	7
		Chapter 2 , Section 6.1, 4.4, 6.2,6.3	
II		**Differentiation**	**15**
	3	Slopes of curves, the slope of the tangent and the derivative, rates of change and their economic significance, simple rules for differentiation, differentiation of sums, products and quotients, second and higher order derivatives.The generalized power rule, composite functions and the chain rule, implicit differentiation, linear approximations and differentials, polynomial approximation, elasticities.	15
		Chapter 4 and 5	
III		**Application of Differentiation to Economics**	**15**
	4	The intermediate-value theorem, the extreme value theorem, the mean value theorem, Taylor's formula, intermediate forms and L' Hopital's rule, inverse functions. **Single-Variable Optimization**: Some basic definitions, a first-derivative test for extreme points, alternative ways of finding maxima and minima, local maxima and minima, convex and concave functions and inflection points.	15
		Chapter 7, Chapter 9 Sections 1-5	
IV		**Linear Algebra and Its applications**	**15**
	5	**Linear Algebra - Vectors and Matrices:** Systems of linear equations, vectors, matrices and matrix operations, matrix	15

		multiplication, rules for matrix multiplication, the transpose. **Determinants and Matrix Inversion:** Determinants of order 2, determinants of order 3, expansion by cofactors, inverse of a matrix, Cramer's rule. Linear independence, The rank of a matrix, Eigen values. Cayley Hamilton theorem and its applications. Chapter 12,13,14	
		[Wherever possible, ICT enabled tools should be used]	

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Sketch the graph of different functions and analyse the continuity of functions	Ap	PSO-1,2,3
CO-2	Apply the simple rules of differentiation to solve problems like linear approximation, polynomial approximation and elasticities	Ap	PSO-1,2,3,6
CO-3	Explore, identify and determine the application of differentiation in various topics like Intermediate value theorem, the extremities of a function etc	Ap	PSO-1,2,3,4
CO-4	Construct matrices and solve various problems related to matrices like finding out inverse of a matrix, eigen values of a matrix etc	C	PSO-1,2,3

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Note: 1 or 2 COs/module

Name of the Course: Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)

1	Sketch the graph of different functions and analyse the continuity of functions	PO 1,2/PSO-1,2,3	Ap	F, C, P, M	L	
2	Apply the simple rules of differentiation to solve problems like linear approximation, polynomial approximation and elasticities	PO 1,2/ PSO-1,2,3,6	Ap	F, C	L	
3	Explore, identify and determine the application of differentiation in various topics like Intermediate value theorem, the extremities of a function etc	PO 1,2 5/PSO-1,2,3,4	Ap	C	L	
4	Construct matrices and solve various problems related to matrices like finding out inverse of a matrix, eigen values of a matrix etc	PO 1,2,6/ PSO-1,2,3	C	C, M	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**
CO 1	3	3	3	-	-	-	-	-	3	3	-	2	-	-	1
CO 2	3	3	3	-	-	3	-	-	3	3	-	-	-	1	2
CO 3	3	3	3	3	-	-	-	-	3	3	2	1	3	-	-
CO 4	3	3	3	-	-	-	1	2	3	3	2	-	-	3	1

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4				✓

Mar Ivanios College (Autonomous)

<table>
<tr><td>Discipline</td><td colspan="5">MATHEMATICS</td></tr>
<tr><td>Course Code</td><td colspan="5">MIUK1DSCMAT105.1</td></tr>
<tr><td>Course Title</td><td colspan="5">Calculus of one and more than one variable</td></tr>
<tr><td>Type of Course</td><td colspan="5">DSC</td></tr>
<tr><td>Semester</td><td colspan="5">I</td></tr>
<tr><td>Academic Level</td><td colspan="5">100 - 199</td></tr>
<tr><td rowspan="2">Course Details</td><td>Credit</td><td>Lecture per week</td><td>Tutorial per week</td><td>Practical per week</td><td>Total Hours/Week</td></tr>
<tr><td>4</td><td>4 hours</td><td>-</td><td>-</td><td>4</td></tr>
<tr><td>Pre-requisites</td><td colspan="5">1. Functions, Limits
2. Differentiation and Integration</td></tr>
<tr><td>Course Summary</td><td colspan="5">This course covers a wide range of topics in calculus and multivariable calculus. It starts with the study of related rates, local linear approximations, and differentials, providing tools to analyze the behavior of functions. Techniques for analyzing functions such as identifying increasing, decreasing, and concave regions are explored, leading to the study of maxima and minima, including applied maximum and minimum problems. Rolle’s and Mean Value Theorems are introduced to understand the behavior of functions over intervals. The course delves into the average value of a function and its applications, along with techniques for evaluating definite integrals by substitution and finding areas between curves.

Moving into multivariable calculus, the course examines functions of two or more variables, exploring partial derivatives,</td></tr>
</table>

	differentiability, and local linearity. Chain rules are introduced to study the derivatives of composite functions, leading to discussions on maxima, minima, and Lagrange Multipliers in multivariable contexts. Integration techniques are extended to double and triple integrals, covering areas, volumes, and surface areas of revolution. Techniques for evaluating double integrals over non-rectangular regions, in polar, cylindrical, and spherical coordinates, are discussed, alongside the concept of change of variables using Jacobians. The course culminates in exploring numerical integration methods like Simpson's rule for practical applications.
Text	H Anton, I Bivens, S Davis, *Calculus*, Wiley 10th Edition. Chapter 2: Sections 2.8, 2.9 Chapter 3: Sections 3.1 – 3.5, 3.8 Chapter 4: Section 4.8, 4.9 Chapter 5: Sections 5.1 – 5.8 Chapter 7: Sections 7.2, 7.5, 7.7 Chapter 13: Sections 13.1 – 13.5, 13.8, 13.9 Chapter 14: Sections 14.1 – 14.3, 14.5, 14.8
References	1. G B Thomas, R L Finney. Calculus, 9th Edition, Addison-Wesley Publishing Company 2. J Stewart. Calculus with Early Transcendental Functions, 7th Edition, Cengage India Private Limited 3. Tom M. Apostol. Calculus, Volume 1, 2nd Edition, John Wiley & Sons

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Differential Calculus of one variable and applications**	**15**
	1	Related rates, local linear approximations, differentials,	5
	2	Analysis of functions: Increase, decrease, concavity	5
	3	Maxima and minima, applied maximum and minimum problems	5

II	**Integral calculus of one variable and applications**		**15**
	1	Average value of a function and its applications	3
	2	Evaluations definite integrals by substitution	3
	4	Integration by parts, Integrating a rational function by partial fractions	5
	5	Numerical integration- Simpson's rule	4
III	**Partial Differentiation and applications**		**15**
	1	Functions of two or more variables	4
		partial derivatives, differentiability, differentials and local linearity,	3
	2	chain rules	4
	3	maxima and minima,	4
IV	**Multiple Integrals and applications**		**15**
	1	Double integrals	4
		Double Integrals over non rectangular regions,	4
	2	Double integrals in polar coordinates	3
	3	Triple integrals	4

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Develop a strong understanding and proficiency in various calculus techniques, including related rates, local linear approximations, differentials, and the analysis of functions such as identifying increasing, decreasing, and concave regions.	U	PSO: 1, 2, 3, 4, 5, 6, 7
CO-2	Equip with problem-solving skills applicable to a	Ap	PSO: 1, 2,

	wide range of mathematical scenarios, including applied maximum and minimum problems, evaluating definite integrals by substitution, finding the area between curves, and determining the length of plane curves and the area of surfaces of revolution.		3, 4, 5, 6, 7
CO-3	Gain a solid understanding of fundamental theoretical concepts in calculus, such as Rolle's and Mean Value Theorems, which are crucial for understanding the behaviour of functions over intervals and for proving important results in calculus.	U	PSO: 1, 2, 3, 4, 5, 6, 7
CO-4	Acquire proficiency in multivariable calculus, including functions of two or more variables, partial derivatives, differentiability, and local linearity. They will also learn advanced topics such as maxima, minima, Lagrange Multipliers, and double and triple integrals.	E	PSO: 1, 2, 3, 4, 5, 6, 7
CO-5	Learn to apply advanced integration techniques such as integration by parts, integrating rational functions by partial fractions, and numerical integration methods like Simpson's rule to solve complex mathematical problems	Ap	PSO: 1, 2, 3, 4, 5, 6, 7
CO-6	Develop spatial visualization skills and a deep understanding of coordinate systems, including rectangular, polar, cylindrical, and spherical coordinates. They will also learn about the concept of change of variables using Jacobians, which is essential for solving problems in various coordinate systems.	Ap	PSO: 1, 2, 3, 4, 5, 6, 7

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Note: 1 or 2 COs/module

Name of the Course: Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)
1	Develop a strong understanding and proficiency in various calculus techniques, including related rates, local linear approximations, differentials, and the analysis of functions such as identifying increasing, decreasing, and concave regions.	PO: 1, 2, 4, 5, 6 / PSO: 1, 2, 3, 4, 5, 6, 7	U	F, C, P	L
2	Equip with problem-solving skills applicable to a wide range of mathematical scenarios, including applied maximum and minimum problems, evaluating definite integrals by substitution, finding the area between curves, and determining the length of plane curves and the area of surfaces of revolution.	PO: 1, 2, 4, 5, 6 / PSO: 1, 2, 3, 4, 5, 6, 7	Ap	F, P	L
3	Gain a solid understanding of fundamental theoretical concepts in calculus, such as Rolle's and Mean Value Theorems, which are crucial for understanding the behaviour of functions over intervals and for proving important results in calculus.	PO: 1, 2, 4, 5, 6 / PSO: 1, 2, 3, 4, 5, 6, 7	U	F, C	L
4	Acquire proficiency in multivariable calculus, including functions of two or more variables, partial derivatives, differentiability, and local linearity. They will also learn advanced topics such as maxima, minima, Lagrange Multipliers, and double and triple integrals.	PO: 1, 2, 4, 5, 6 / PSO: 1, 2, 3, 4, 5, 6, 7	E	C, P	L
5	Learn to apply advanced integration	PO: 1, 2,	Ap	F, C, P	L

	techniques such as integration by parts, integrating rational functions by partial fractions, and numerical integration methods like Simpson's rule to solve complex mathematical problems	4, 5, 6 / PSO: 1, 2, 3, 4, 5, 6, 7			
6	Develop spatial visualization skills and a deep understanding of coordinate systems, including rectangular, polar, cylindrical, and spherical coordinates. They will also learn about the concept of change of variables using Jacobians, which is essential for solving problems in various coordinate systems.	PO: 1, 2, 4, 5, 6 / PSO: 1, 2, 3, 4, 5, 6, 7	Ap	F, C, M	L

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	3	3	2	1	1	1	2	-	1	3	-	1	1	1	-
CO 2	3	3	2	1	1	1	2	-	1	3	-	1	1	1	-
CO 3	3	3	2	1	1	1	2	-	1	3	-	1	1	1	-
CO 4	3	3	2	1	1	1	2	-	1	3	-	1	1	1	-
CO 5	3	3	2	1	1	1	2	-	1	3	-	1	1	1	-
CO 6	3	3	2	1	1	1	2	-	1	3	-	1	1	1	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam

- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓			✓
CO 4		✓		✓
CO 5		✓		✓
CO 6			✓	

Mar Ivanios College (Autonomous)

Discipline	**MATHEMATICS**				
Course Code	MIUK1MDCMAT106.1				
Course Title	**Quantitative Techniques and Aptitude** **(Basic Mathematics for Competitive Examinations)**				
Type of Course	MDC				
Semester	I				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	3	3 hours	-	-	3
Pre-requisites	Basic High School Mathematics.				
References	1. R. S. Aggarwal, *Quantitative Aptitude*, S. Chand, New Delhi, 2017. 2. M Tyra and K. Kundan, *Practice Book of Quicker Maths*, BSC Publishing Company Pvt Ltd, New Delhi, 2015. 3. Rajesh Verma, *Fast Track Obective Arithmetic*, Arihant Publications (India) Ltd., New Delhi.				
Course Summary	The course discusses basic mathematics and quantitative techniques essential for competitive examinations. The course covers basic arithmetic techniques, percentage, profit and loss, time related problems etc. It also introduces the mensuration, probability and mathematics related to bank and market. The syllabus is aligned with the requirements of any standard competitive examination.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Basic Number Problems**	**15**
	1	Number system, Basic arithmetic operations, BODMAS rule, HCF and LCM, Decimal Fractions, Simplification, Word problems based on numbers, Square roots and Cube roots, Average, Problems on Ages, Surds and Indices, Logarithms.	
II		**Percentage and Proportion**	**15**
	2	Percentage, Profit and Loss, Ratio and Proportion, Partnership, Pipes and Cisterns, Time, Work and Wages, Time and Distance, Boats and Streams, Problems on Trains, Alligation or Mixture, Simple Interest, Compound Interest, Area and Volume, Races and Games of skill.	
III		**Elementary Mensurations and Probability**	**15**
	3	Elementary Mensuration, Calendar, Clocks, Permutations and Combinations, Probability, True Discount, Banker's Discount, Heights and Distances, Stocks and Shares, Odd man out and series.	

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the basic arithmetic operations and acquire ability to solve number related problems.	U	1,2,3,5
CO-2	Understand concepts of percentage and proportion, different types of work and time related problems and acquire ability to solve them.	R	1,2,3,5
CO-3	Understand the basic mensuration, probability, mathematics related discounts and acquire ability to solve related problems.	Ap	1,2,3,5
CO-4	Acquire expertise to perform successfully in the mathematical/quantitative part of competitive examinations.	E	1,2,3,5

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Note: 1 or 2 COs/module

Name of the Course: Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1	Understand the basic arithmetic operations and acquire ability to solve number related problems.	PO 1,2,5	U	P	L/T	
2	Understand concepts of percentage and proportion, different types of work and time related problems and acquire ability to solve them.	PO 1,2,5	R	P	L/T	
3	Understand the basic mensuration, probability, mathematics related discounts and acquire ability to solve related problems.	PO 1,2,5	Ap	P	L/T	
4	Acquire expertise to perform successfully in the mathematical/quantitative part of competitive examinations.	PO 1,2,5	E	P	L/T	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	1	2	3		3				3	3			2		
CO 2	1	2	3		3				3	3			2		
CO 3	1	2	3		3				3	3			2		
CO 4	1	2	3		3				3	3			2		

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓	✓	✓
CO 2	✓	✓	✓	✓
CO 3	✓	✓	✓	✓
CO 4	✓	✓	✓	✓

SEMESTER - II

Mar Ivanios College (Autonomous)

<table>
<tr><td>Discipline</td><td colspan="5">MATHEMATICS</td></tr>
<tr><td>Course Code</td><td colspan="5">MIUK2DSCMAT150.1</td></tr>
<tr><td>Course Title</td><td colspan="5">Foundations of Mathematics - II</td></tr>
<tr><td>Type of Course</td><td colspan="5">DSC</td></tr>
<tr><td>Semester</td><td colspan="5">II</td></tr>
<tr><td>Academic Level</td><td colspan="5">100 – 199</td></tr>
<tr><td rowspan="2">Course Details</td><td>Credit</td><td>Lecture per week</td><td>Tutorial per week</td><td>Practical per week</td><td>Total Hours/Week</td></tr>
<tr><td>4</td><td>4 hours</td><td>-</td><td>-</td><td>4</td></tr>
<tr><td>Pre-requisites</td><td colspan="5">1. Basic differentiation and derivatives of standard functions
2. Basics of integration and area problems</td></tr>
<tr><td></td><td colspan="5">Text: H Anton, I Bivens, S Davis. Calculus, 10th Edition, John Wiley& Sons.

References:

1. George B. Thomas, Ross L. Finney. Calculus and analytic geometry, 9th Edition, Addison-wesley publishing Company.
2. K F Riley, M P Hobson, S J Bence. Mathematical Methods for Physics and Engineering, 3rd Edition, Cambridge University Press
3. Mary L Boas. Mathematics Methods in the Physical Sciences, 3rd Edition,Wiley
4. Erwin Kreyszig. Advanced Engineering Mathematics, 10th Edition, Wiley-India</td></tr>
</table>

Course Summary	This course comprehensively explores topics in differentiation, including derivatives of standard functions and their applications. It delves into various techniques of integration and thoroughly examines applications of integration.

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Applications of derivatives**	**15**
	1	Chain rule and implicit differentiation	2
	2	Related rates	3
	3	Local linear approximation	2
	4	Tangent lines to parametric curves	2
	5	Tangent lines to polar curves	2
	6	Derivatives of logarithmic functions, logarithmic differentiation	2
	7	Differentiability of inverse functions, derivatives of exponential functions	2
	The topics in this module can be found in chapters 2, 6 and 10 sections 2.6, 2.7, 2.8, 2.9, 6.2, 6.3, 10.1, 10.3 **of text.**		
II		**Analysis of functions**	**15**
	8	Increasing and decreasing functions and their analysis	2
	9	concavity of functions, points of inflections of a function and applications	2
	10	relative maxima and minima of functions, critical points	2

	11	second derivative tests, multiplicity of roots and its geometrical interpretation	2
	12	Absolute maximum and minimum, their behavior on various types of intervals	2
	13	applications of extrema problems on infinite, infinite intervals and applied maximum minimum problems	2
	14	Indeterminate forms and L'Hopital's rule	3
	The topics in this module can be found in chapters 3 and 6 sections 3.1, 3.2, 3.3, 3.4, 3.5, 6.5 **of text**		
III	**Integration**		**15**
	15	Problem of calculating area of plane regions with curvilinear boundaries	2
	16	Antiderivatives, the indefinite integral, their properties,	2
	17	Integral curves, integration from the view point of differential equations	2
	18	Slop fields, the fundamental theorem of calculus part 1, relationship between definite and indefinite integrals,	2
	19	Mean value theorem for integrals, the fundamental theorem of calculus part 2,	2
	20	Integration by substitution, integration by parts	2
	21	trigonometric substitution and partial fractions	2
	22	hyperbolic functions	1
	The topics in this module can be found in chapters 4, and 7 sections 4.1. 4.2, 4,3, 4,4, 4,5, 4.6, 4.9, 7.2, 7.3, 7.4, 7.5, 7.8 **of text.**		
IV	**Applications of integration**		**15**
	23	Arc lengths parametric curves and arc length of polar curves	2
	24	Area between two curves	3
	25	Finding volumes of some three - dimensional solids by various methods like slicing, disks and washers	5

	26	Finding length of a plane curve	2
	27	Surface of revolution and its area	3
	The topics in this module can be found in chapters 5 and 10 sections 5.1, 5.2, 5.4, 5.5, 10.1, 10.3 **of text**		

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Apply the concept of differentiation in real life situation.	Ap	PSO-1,2,3, 4, 7, 8
CO-2	Define maxima, minima, critical points and points of inflection.	U	PSO-1,3, 4, 6, 7, 8
CO-3	Describe the integration of a function and learn its physical interpretation through various examples.	Ap	PSO-1,2,3, 4, 7, 8
CO-4	Demonstrate various application of integration	An	PSO-1,2, 3, 4, 7, 8
CO-5	Sketch curves using ICT tools.	Ap	PSO-1,5, 6, 7, 8
CO-6	Compute area, volume, length, arc length, area of surfaces using integration technique	E	PSO-1,2, 3, 4, 7, 8

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Note: 1 or 2 COs/module

Name of the Course: Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO1	Apply the concept of differentiation in real life	PO-1,2, 4,5, 6, 7	Ap	F, C	L	

	situation.					
CO 2	Define maxima, minima, critical points and points of inflection.	PO-1,2, 4,5, 6, 7	U	F, C, M	L	
CO3	Describe the integration of a function and learn its physical interpretation through various examples.	PO-1,2, 4,5, 6, 7	Ap	F, C, P	L	
CO 4	Demonstrate various application of integration	PO-1,2, 4,5, 6, 7	An	F,C, M	L	
CO 5	Sketch curves using ICT tools.	PO-1,2, 4,5, 6, 7	Ap	P, M	L	
CO 6	Compute area, volume, length, arc length, area of surfaces using integration technique	PO-1,2, 4,5, 6, 7	E	F, C, P, M	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**
CO 1	3	2	3	2	-	-	1	1	3	3	-	1	3	1	1
CO 2	3	-	3	2	-	3	1	1	3	3	-	1	3	1	1
CO 3	3	2	3	2	-	-	1	1	3	3	-	1	3	1	1

CO 4	3	2	3	2	-	-	1	1	3	3	-	1	3	1	1
CO 5	3	-	-	-	2	3	1	1	3	3	-	1	3	1	1
CO 6	3	2	3	2	-	-	1	1	3	3	-	1	3	1	1

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓			✓
CO 4	✓			✓
CO 5		✓		
CO 6	✓			✓

Mar Ivanios College (Autonomous)

Discipline	**MATHEMATICS**				
Course Code	MIUK2DSCMAT151.1				
Course Title	**Mathematics for Physical Sciences – II**				
Type of Course	DSC				
Semester	II				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-	-	4
Pre-requisites	Concept of vectors, basic idea of probability, idea of complex numbers.				
Text Books	**Texts:** **Text I:** Anton, I Bivens, S Davis. Calculus, 10th Edition, John Wiley & Sons **Text II:** Grewal, Higher Engineering Mathematics, 42nd edition **References:** 1. George B. Thomas, Ross L. Finney, *Calculus and analytic geometry*, 9th Edition, Addison-wesley publishing Company. 2. K. F. Riley, M. P. Hobson, S. J. Bence, *Mathematical Methods for Physics and Engineering*, 3rd Edition, Cambridge				

	University Press. 3. Mary L. Boas, *Mathematics Methods in the Physical Sciences*, 3rd Edition, Wiley. 4. Erwin Kreyszig, *Advanced Engineering mathematics*, 10thEdition,Wiley- India.
Course Summary	The course covers a comprehensive range of topics in Integration and its applications. It begins with the study of different techniques of Integration. Various functions are discussed. Integrations of various functions are studied. Application of integration are discussed along with Area between curves and Volume are studied. Concept of Vector fields are studied. Surface integrals and and its applications are discussed. Important theorems like Green's theorem, Stokes theorem and Divergence theorem are studied. Revision of Probability theory. Independent events and Bayes are studied. Revision of complex numbers. Complex functions are introduced. Analytic functions are explained. Cauchy's theorem, Cauchy's integral formula are discussed. Finally Residues and calculation of Residues are studied.

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Integration**	**10**
	1	The module should begin with introduction to indefinite integral, Integration techniques like substitution, by parts, trigonometric substitution are to be covered using Sections 4.3, 4.5 and 4.6.	5
		Integrating trigonometric functions, trigonometric substitution, Integrating rational functions by Partial fractions are to be covered in Sections 7.1, 7.2, 7.3, 7.4 and 7.5.	5
		[The topics in this module can be found in Chapter 4; Sections 4.2, 4.3, 4.5, 4.6 & Chapter 7 : 7.1, 7.2, 7.3, 7.4, 7.5 of Text. I]	
II		**Application of Integration & Vector Integration**	**20**

	2	We can proceed as in section 5.1 to find area between two curves. Sections 5.2 and 5.3 discuss two method to find volumes involving integration in one variable. Area of revolution must be covered as in section 5.5. **ICT tools can be used to enhance effective learning.**	5
		Vector Fields, Line Integrals, Independence of Path and Conservative Vector Fields are introduced, Surface Integrals, Applications of Surface Integrals; Important theorems like the Greens theorem, Stokes Theorem and Divergence Theorem are discussed in Section 15.1 to 15.8. [**All theorems in this module should be discussed without proof]** **ICT tools can be used to enhance effective learning.**	15
	[The topics in this module can be found in Chapter5, Sections 5.1, 5.2, 5.3 & 5.5 **Chapter 13; section 13.6 Chapter 15; Sections 15.1 to 15.8 of Text I]**		
III	**Probability**		**10**
	3	Introduction to Probability, Set notations are explained, Concept of independent events along with Bayes theorem are studied.	
	[The topics in this module can be found in Chapter 26; Sections 26.1 to 26.6 of Text II]		
IV	**Complex Analysis**		**20**
	4	Concept of Complex numbers is revised, Complex functions are introduced, and Exponential functions of a complex variable are explained.	3
		Limit of a complex function are introduced, Derivative of f(z) are explained and taking derivatives. Concept of Analytic functions are introduced. Definition of Harmonic function is given. Cauchy's theorem, Cauchy's integral formula are studied. Applying Cauchy's theorem and Cauchy's integral formula. Finally Residues are studied. Calculation of Residues.	17
	[**The topics in this module can be found in Chapter: 20 Sections 20.1 to 20.5, 20.12 to 20.14, 20.16(Laurent Series only),20.17 to 20.20 of the Text II.]**		

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	perform various operations on Integration, including substitution, integration by parts, trigonometric substitution. Gain the knowledge of partial fractions. Apply the integration in rational functions.	U	PSO-1,2
CO-2	Apply the concept of integration to find Area and Volume between two curves. gain an understanding of application of integration.	Ap	PSO-1,6
CO-3	develop competence in vector field, understanding concepts such as independence of path and conservative vector fields, understanding Green's theorem, Stokes theorem and Divergence theorem.	,R	PSO-1,3
CO-4	Master the concept of probability theory. gain the idea of set notations, understanding independent events and study Bayes theorem.	C	PSO-1,7
CO-5	Revise the concept of complex numbers, gain the concept of complex functions. finding limit of complex function, calculation of exponential function of complex variable.	E	PSO-1,5
CO-6	They will learn about derivatives of complex functions. Master the concept of Analytic functions, understanding Cauchy's theorem and Cauchy's integral formula and their applications. Master the concept of residues including their calculation.	C	PSO-1,8

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Note: 1 or 2 COs/module

Name of the Course: Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/ PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO-1	perform various operations on Integration, including substitution, integration by parts, trigonometric substitution. Gain the knowledge of partial fractions. Apply the integration in	PSO -1,2	U	F, C	**L**	

	rational functions.					
CO-2	Apply the concept of integration to find Area and Volume between two curves. gain an understanding of application of integration.	PSO -1,6	Ap	P	**L**	
CO-3	develop competence in vector field, understanding concepts such as independence of path and conservative vector fields, understanding Green's theorem, Stokes theorem and Divergence theorem.	PSO -1,3	,R	U	**L**	
CO-4	Master the concept of probability theory. gain the idea of set notations, understanding independent events and study Bayes theorem.	PSO -1,7	C	R	**L**	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	**PSO 2**	**PSO 2**	**PSO 4**	**PSO 5**	**PSO 6**	**PSO 7**	**PS O8**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO 7**
CO 1	3	1	3	2	3	3	2	1	3	1	3	3	2	3	2
CO 2	2	3	1	3	1	2	2	1	1	2	3	2	3	3	2
CO 3	1	2	1	3	1	2	3	2	2	3	1	1	2	2	1
CO 4	3	3	3	2	2	3	1	3	2	1	2	3	2	1	2
CO 5	2	3	2	1	3	3	3	2	3	3	2	2	2	3	2

Correlation Levels:

Level	**Correlation**
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓			✓
CO 4		✓		✓
CO 5		✓		✓
CO 6			✓	

Mar Ivanios College (Autonomous)

Discipline	**MATHEMATICS**				
Course Code	MIUK2DSCMAT152.1				
Course Title	**Mathematics for Life Sciences - II**				
Type of Course	DSC				
Semester	II				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-	-	4
Pre-requisites	1. High School Level Basic Mathematics 2. Basic Set Theory, Functions				
Course Summary	This course offers a comprehensive exploration of calculus and its applications in various fields. Beginning with the concept of limits, students delve into special limits and differentiation using first principles, product, quotient, and chain rules, as well as implicit and logarithmic differentiation. Higher-order derivatives extend understanding into more complex functions. Basic rules in integration provide a foundation for further exploration. Maxima and minima problems are tackled alongside geometric interpretations, paving the way for understanding optimization. Differential equations are introduced, covering various forms including linear and nonlinear, leading to discussions on mathematical modelling in discrete and continuous settings, and exploring applications in both differential equations and graph theory.				
Text	Edward Batschelet, *Introduction to Mathematics for Life Scientists,*				

	Springer, 1973. Chapter 8: Sections: 8.1 – 8.4 Chapter 9: Sections: 9.1 – 9.7 Chapter 11: Sections 11.1 – 11.8 Chapter 12: Sections: 12.1 – 12.3
References	1. S. T. Tan, *Finite Mathematics for the Managerial, Life and Social Sciences*, 9th Edition, Cengage Learning. 2. Glenn Ledder, *Mathematics for the Life Sciences*, Springer. 3. Raina S. Robeva, James R. Kirkwood, Robin L. Davies, Leon S. Farhy, Michael L. Johnson, Boris P. Kovatchev, and Marty Straume, *An Invitation to Bio mathematics*, ELSEVIER. 4. Fred Brauer, Carlos Castillo-Chavez, *Mathematical Models in Population Biology and Epidemiology*, 2nd edition, Springer, New York, 2011. 5. Michael Y Li, *An Introduction to Mathematical Modelling of Infectious Diseases*, Springer, 2018. 6. Ivo M Foppa, *A Historical Introduction to Mathematical Modeling of Infectious Diseases: Seminal Papers in Epidemiology*, Academic Press, 2017.

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Differentiation and Integration**	**15**
	1	Limit of a function	1
		Special limits	1
	2	Differentiation by first principle	2
	3	Product rule	1
		Quotient rule	1

		Chain rule	2
	4	Implicit Differentiation	1
		Logarithmic Differentiation	1
	5	Higher order derivatives	1
	6	Basic rules in integration	4
II	**Partial Differentiation**		**15**
	1	Introduction,	3
	2	Partial Derivatives - Simple Problems,	6
	3	Maxima and Minima	6
III	**Differential Equations**		**15**
	1	Geometric Interpretation	3
	2	Differential equations of the form $y' = ay, y' = ay + b, y' = ay^2 + by + c, y' = k\frac{y}{x}$	6
	3	System of linear differential equations	3
	4	System of nonlinear differential equations	3
IV	**Introduction to Mathematical Modelling**		**15**
	1	Overview of mathematical modelling	1
	2	Discrete time linear models	2
	3	Discrete time non-linear models	2
	4	Modelling with a Differential Equation	6
	5	Modelling Using Graph Theory	4

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	demonstrate a strong understanding of fundamental calculus concepts including limits of functions, differentiation principles, and basic rules in	R	PSO: 1, 2, 3, 4, 5, 6, 7

	integration.		
CO-2	master differentiation techniques such as the product, quotient, and chain rules, as well as implicit and logarithmic differentiation, enabling them to solve complex problems involving derivatives, especially into their disciplines.	U	PSO: 1, 2, 3, 4, 5, 6, 7
CO-3	calculate higher-order derivatives and understand their significance in analysing functions and their behaviour.	Ap	PSO: 1, 2, 3, 4, 5, 6, 7
CO-4	apply calculus concepts to solve optimization problems, including identifying maxima and minima and interpreting geometrically.	R	PSO: 1, 2, 3, 4, 5, 6, 7
CO-5	acquire the skills to solve various types of ordinary differential equations, including linear and nonlinear forms, and understand their applications in mathematical modelling.	C	PSO: 1, 2, 3, 4, 5, 6, 7
CO-6	gain the ability to model real-world scenarios using both differential equations and graph theory, and analyse discrete and continuous systems to make informed decisions.	C	PSO: 1, 2, 3, 4, 5, 6, 7

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)
1	demonstrate a strong understanding of fundamental calculus concepts including limits of functions, differentiation principles, and basic rules in integration.	PO: 1, 2, 3, 4, 5, 6, 7 / PSO: 1, 2, 3, 4, 5, 6, 7	R	F, C	L
2	master differentiation techniques such as the product, quotient, and chain rules, as well as implicit and logarithmic differentiation, enabling them to solve complex problems involving derivatives, especially into their disciplines.	PO: 1, 2, 3, 4, 5, 6, 7 / PSO: 1, 2, 3, 4, 5, 6, 7	U	F, C, P	L
3	calculate higher-order derivatives and understand their significance in analysing functions and their behaviour.	PO: 1, 2, 3, 4, 5, 6, 7 / PSO: 1, 2, 3, 4, 5, 6, 7	Ap	F, C, P	L
4	apply calculus concepts to solve optimization	PO: 1, 2, 3, 4, 5, 6,	R	C, P	L

	problems, including identifying maxima and minima and interpreting geometrically.	7 / PSO: 1, 2, 3, 4, 5, 6, 7			
5	acquire the skills to solve various types of ordinary differential equations, including linear and nonlinear forms, and understand their applications in mathematical modelling.	PO: 1, 2, 3, 4, 5, 6, 7 / PSO: 1, 2, 3, 4, 5, 6, 7	C	P	L
6	gain the ability to model real-world scenarios using both differential equations and graph theory, and analyse discrete and continuous systems to make informed decisions.	PO: 1, 2, 3, 4, 5, 6, 7 / PSO: 1, 2, 3, 4, 5, 6, 7	C	F, C, P	L

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO 4	PSO5	PSO6	PSO7	PSO8	PO1	PO2	PO3	PO4	PO5	PO6	PO 7
CO 1	3	3	2	1	1	1	2	-	1	3	1	1	1	1	1
CO 2	3	3	2	1	1	1	2	-	1	3	1	1	1	1	1
CO 3	3	3	2	1	1	1	2	-	1	3	1	1	1	1	1
CO 4	3	3	2	1	1	1	2	-	1	3	1	1	1	1	1
CO 5	3	3	2	1	1	1	2	-	1	3	1	1	1	1	1
CO 6	3	3	2	1	1	1	2	-	1	3	1	1	1	1	1

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓			✓
CO 4		✓		✓
CO 5		✓		✓
CO 6			✓	

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Mar Ivanios College (Autonomous)

Discipline	**MATHEMATICS**				
Course Code	MIUK2DSCMAT153.1				
Course Title	**Mathematics for Social Sciences - II**				
Type of Course	DSC				
Semester	II				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4	-	-	4
Pre-requisites	1. Functions 2. Differentiation				
Course Summary	The emphasis of this courses is on computational skills on Business Mathematics and their practical application, with practical application being predominant. It covers several topics such as interpolation, extrapolation, integration techniques, application of Mathematics in finance and index numbers. This course is mainly intended for second semester undergraduate students with Commerce as their major discipline.				
Prescribed Texts	1.B M Aggarwal – Business Mathematics and Statistics, Ane Books Pvt Ltd, 2023. 2. D.C. Sancheti, V.K. Kapoor Business Mathematics, Sultan Chand & SonsPublications, 2006.				
Reference	1. "Business Mathematics" by Gary Clendenen and Stanley A.				

Books	Salzman, 13th Edition, Pearson Publishers 2. "Business Mathematics" by Cheryl Cleaves, Margie Hobbs, and Jeffrey Noble, 9th Edition, Pearson Publishers 3. "Essential Mathematics for Economics and Business" by Teresa Bradley:2nd Edition, Wiley India Private Limited

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Interpolation and Extrapolation**	**12**
	1	Introduction, Importance, methods of interpolation – Newtons Forward and Backward method, Lagranges method of Extrapolation	12
II		**Integral Calculus**	**12**
	3	Introduction, General Rules, Some Standard results, Method of substitution, Partial fractions, Some standard substitutions, Integration by parts [The topics to be discussed in this module can be found in Chapter 6 of Text 1]	12
III		**Mathematical Application in Business**	**12**
	4	Depreciation- methods of depreciation, partial year depreciation and changes in estimates, accelerated depreciation methods. Payroll cost calculations, Property tax calculations, exchange rates and currency conversion. [The topics to be discussed in this module can be found in Chapter 17 of Reference Text 2]	12
IV		**Basic Mathematics of Finance**	**12**
	5	Simple interest-Compound interest-Effective rate of interest-Present Value-Net Present Value-Future Value-Perpetuity-Annuities-Sinking Funds-Calculations of EMI-Calculation of returns under normal rate of return, effective rate of return and Compound Annual Growth Rate (CAGR) [The topics to be discussed in this module can be found in Chapter 14 of Reference Text 2]	12
V		**Index Numbers**	**12**

	6	Index Numbers: Definition, Simple and composite index numbers, types of index numbers, methods of construction of price index numbers, Laspeyer's price index number, Paasche's price index number, Fisher ideal index number, construction of cost living index, consumer price index,whole sale index, share price index. [The topics to be discussed in this module can be found in Chapter 6 of Text 1]	12
		[Wherever possible, ICT enabled tools should be used]	

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Compute the problems involving interpolation and extrapolation	Ap	PSO-1,2,3
CO-2	Integrate different functions and apply integration techniques to solve various problems related to it	Ap	PSO-1,2,3
CO-3	Estimate property tax , exchange rates and determine currency conversion	E	PSO-1,2,3
CO-4	Classify different annuinities , sinking funds and compute mathematical problems related to it	U	PSO-1,2,3
CO-5	Construct cost living index and compute problems related to index numbers	E	PSO-1,2,3

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Note: 1 or 2 COs/module

Name of the Course: Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1	Compute the	PO	Ap	F, C	L	

	problems involving interpolation and extrapolation	1,2/PSO-1,2,3				
2	Integrate different functions and apply integration techniques to solve various problems related to it	PO 1,2/PSO-1,2,3	Ap	F, C, P	L	
3	Estimate property tax, exchange rates and determine currency conversion	PO 1,2/PSO-1,2,3	E	C	L	
4	Classify different annuities, sinking funds and compute mathematical problems related to it	PO 1,2/PSO-1,2,3	U	C, P	L	
5	Construct cost living index and compute problems related to index numbers	PO 1,2/ PSO-1,2,3	E	F, C	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**
CO 1	3	3	3	-	-	2	1	1	3	3	-	1	-	2	1

CO 2	3	3	3	-	-	-	1	1	3	3	2	-	-	1	-
CO 3	3	3	3	-	-	-	1	1	3	3	-	1	-	2	-
CO 4	3	3	3	2	-	-	1	1	3	3	-	2	1	-	-
CO 5	3	3	3	-	-	2	1	2	3	3	-	2	1	-	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓			✓
CO 4		✓		✓
CO 5		✓		✓

Mar Ivanios College (Autonomous)

<table>
<tr><td>Discipline</td><td colspan="5">MATHEMATICS</td></tr>
<tr><td>Course Code</td><td colspan="5">MIUK2DSCMAT154.1</td></tr>
<tr><td>Course Title</td><td colspan="5">Mathematical Methods for Finance - II</td></tr>
<tr><td>Type of Course</td><td colspan="5">DSC</td></tr>
<tr><td>Semester</td><td colspan="5">II</td></tr>
<tr><td>Academic Level</td><td colspan="5">100 - 199</td></tr>
<tr><td rowspan="2">Course Details</td><td>Credit</td><td>Lecture per week</td><td>Tutorial per week</td><td>Practical per week</td><td>Total Hours/Week</td></tr>
<tr><td>4</td><td>3 hours</td><td>1</td><td>2 hours</td><td>5</td></tr>
<tr><td>Pre-requisites</td><td colspan="5">1. Functions of one variable
2. Differentiation</td></tr>
<tr><td>Course Summary</td><td colspan="5">This course at the undergraduate level typically provides students with the mathematical tools and techniques necessary for understanding and analysing economic concepts and models. It talks about Exponential and logarithmic functions, multivariable functions and its application, Integral Calculus, differential equations and difference equations. This course is designed for second semester undergraduate level economics students.</td></tr>
<tr><td>Prescribed Text</td><td colspan="5">Knut Sydsaeter, Peter J. Hammond: Mathematics for Economic Analysis, Pearson, 1995.</td></tr>
<tr><td>Reference Textbooks</td><td colspan="5">1 G D Allen, Mathematical Analysis for Economics, AITBS Publishers, D-2/15. Krishnan Nagar, New Delhi
2 Taro Yamane, Mathematics for Economists, An Elementary Survey, PHI, New Delhi.
3 Chiang A.C. and K.Wainwright, Fundamental Methods of Mathematical Economics, 4th Edition, McGraw-Hill, New York,</td></tr>
</table>

	2005.(cw) 4 Dowling E.T, Introduction to Mathematical Economics, 2nd Edition, Schaum's Series, McGraw- Hill, New York, 2003(ETD)

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Functions of Several variables and its Applications**	**12**
	1	**Functions of Several Variables:** Functions of two or more variables, geometric representations of functions of several variables, partial derivatives with two variables, partial derivatives and tangent planes, partial derivatives with many variables, partial derivatives in Economics, linear models with quadratic objectives.	7
	2	The chain rule, more general chain rules, derivatives of functions defined implicitly, partial elasticities, homogeneous functions of two variables, linear approximations and differentials.	5
		Chapter 15 Section 1-7, Chapter 16 Sections 1-5, 8, 9	
II		**Integration**	**12**
	3	**Integration:** Areas under curves, indefinite integrals, the definite integral, economic application of integration. **Further Topics in Integration:** Integration by parts, integration by substitution, extending the concept of the integral, a note on income distribution.	12
		Chapter 10 and 11	
III		**Difference Equations**	**12**
	4	**Difference Equations:** First order difference equations, compound interest and present discounted values, linear equations with a variable coefficient, second order equations, second order equations with constant coefficients.	12
		Chapter 20	
IV		**Differential Equations**	**12**
	5	**Differential Equations:** First order differential equations, the direction is given – find the path, separable differential equations-I, separable differential equations-II, first order linear differential equations-I, first order linear differential equations-II, qualitative theory and stability, second order differential equations, second order differential equations with constant coefficients.	12
		Chapter 21	
V		**Exponential and Logarithmic Functions**:	**12**
	6	**Exponential and Logarithmic Functions**: The natural	

		exponential function, the natural logarithmic function, generalizations, applications of exponentials and logarithms, compound interest and present discounted values.	
		Chapter 14 Sections 1-4	
		[Wherever possible, ICT enabled tools should be used]	

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Apply the concept of partial derivatives and evaluate partial elasticities, and differentials	Ap	PSO-1,2,3
CO-2	Explore the ideas of Integral calculus in evaluating income distribution and apply different techniques of integration	Ap	PSO-1,2,3
CO-3	Discuss and illustrate various problems related to difference equations	Ap	PSO-1,2,3
CO-4	Evaluate first order and second order differential equations	E	PSO-1,2,3
CO-5	Apply the concept of exponential and logarithmic functions in Economic models	Ap	PSO-1,2,3

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Note: 1 or 2 COs/module

Name of the Course: Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/ PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
1	Apply the concept of partial derivatives and evaluate partial elasticities, and differentials	PO 1,2/PSO-1,2,3	Ap	F, C	L	
2	Explore the ideas of Integral calculus in evaluating income distribution and apply different techniques of integration	PO 1,2 / PSO-1,2,3	Ap	F, C, M	L	
3	Discuss and illustrate various problems related to difference equations	PO 1,2 / PSO-1,2,3	E	C, M	L	
4	Evaluate first order and second order differential equations	PO 1,2 /PSO-1,2,3	E	C, M	L	
5	Apply the concept of exponential and logarithmic functions in Economic models	PO 1,2 / PSO-1,2,3	Ap	C	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	3	3	-	2	1	-	-	3	3	-	-	-	-	-
CO 2	3	3	3	-	2	2	2	1	3	3	-	-	1	-	2
CO 3	3	3	3	-	2	-	1	2	3	3	-	1		2	-
CO 4	3	3	3	-	1	-	-	2	3	3	-	2	1	-	-
CO 5	3	3	3	-	-	2	1	1	3	3	-	-	2	-	1

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓	✓		✓
CO 4		✓		✓
CO 5		✓		

Mar Ivanios College (Autonomous)

Discipline	**MATHEMATICS**				
Course Code	MIUK2DSCMAT155.1				
Course Title	**Linear Algebra and Numerical Approximations**				
Type of Course	DSC				
Semester	II				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-	-	4
Pre-requisites	1. Higher Secondary level matrices and algebra of matrices 2. Solving equations				
Course Summary	This mathematics course provides a comprehensive understanding of matrix algebra and its applications. Topics include types of matrices, elementary row operations, echelon form, and the computation of matrix inverses using elementary operations. Students will learn to solve systems of linear equations, both non-homogeneous and homogeneous, and explore concepts of vectors, linear independence, and dependence. Advanced topics such as characteristic equations, eigenvalues, eigenvectors, and the Cayley-Hamilton Theorem are covered, along with techniques for diagonalization and diagonalization of symmetric matrices. Additionally, the course introduces methods for solving algebraic and transcendental equations, including the Regula Falsi method and the Newton-Raphson method, as well as iterative methods for solving linear simultaneous equations. Practical applications are				

	emphasized through techniques like Gauss elimination, LU-factorization, least square method, and matrix eigenvalue problems, ensuring students gain both theoretical knowledge and practical problem-solving skills.
Texts	1. Advanced Engineering Mathematics, Erwin Kreyszig, Wiley International Edition, 9th edition. 2. Higher Engineering Mathematics, B. S. Grewal, Khanna Publishers, 39th edition. Chapter 7: Sections 7.1 – 7.9 of Text 1. Chapter 8: Sections 8.1 – 8.5 of Text 1. Chapter 20: Section 20.1 – 20.3, 20.5 – 20.9 of Text 1 Sections 27.1 – 27.4, 27.6 of text 2.
References	1. Gilbert Strang, Linear Algebra and its Applications, Fourth Edition, Wellesley-Cambridge Press. 2. David C Lay: Linear Algebra, Pearson. 3. T S Blyth, E F Robertson: Linear Algebra, Springer, Second Edition.

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Matrices and Linear Systems**	**15**
	1	Types of matrices, submatrices	2
	2	Elementary row operations	1
		Echelon form	3
	3	Inverse of a matrix using elementary operations	2
	4	Systems of Linear equations	1
		non-homogeneous systems	3
		homogeneous systems	3
II		**Matrix Eigen Value problems**	**15**
	1	Vectors	2
		Linear independence and dependence of vectors	2
	2	Characteristic equations	2
		Eigen values and eigen vectors	3
	3	Cayley Hamilton Theorem	2
	4	Diagonalization	2
		diagonalization of symmetric matrices	2
III		**Numerical Linear Algebra**	**15**
	1	Gauss Eliminations	2
		LU- factorization	3

	2	Matrix Inversion	2
	3	Solution by Iteration, Least square method	2
	4	Matrix eigen value problems	3
	5	Tridiagonalization and QR – factorization	3
IV	**Numerical Methods**		**15**
	1	Solution of algebraic and transcendental equations – Regula Falsi method,	3
		Newton Raphson method.	3
	2	Approximate solution of equations- Horner's method.	4
	3	Solution of linear simultaneous equations – Iterative methods.	5

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Demonstrate proficiency in manipulating matrices, including identifying types of matrices, performing elementary row operations, and determining submatrices, leading to a deep understanding of matrix algebra fundamentals.	U	PSO: 1, 2, 3, 4, 5, 6, 7
CO-2	Gain a comprehensive understanding of vector spaces, including concepts of vectors, linear independence, and dependence, enabling them to analyze and manipulate vectors in various mathematical contexts.	An	PSO: 1, 2, 3, 4, 5, 6, 7
CO-3	Demonstrate competency in eigenvalue analysis, including computing characteristic equations, determining eigenvalues and eigenvectors, and applying the Cayley-Hamilton Theorem, leading to the understanding of diagonalization and diagonalization of symmetric matrices.	U	PSO: 1, 2, 3, 4, 5, 6, 7
CO-4	Acquire proficiency in numerical methods for solving algebraic and transcendental equations, such as the Regula Falsi method, Newton-Raphson method, and approximate solution techniques like Horner's method, providing them with tools for practical problem-solving in various mathematical scenarios.	E	PSO: 1, 2, 3, 4, 5, 6, 7
CO-5	Learn to apply advanced techniques such as tridiagonalization, QR-factorization, and the least square method to solve matrix eigenvalue problems and linear simultaneous equations, fostering their ability to apply mathematical concepts to real-world problems.	Ap	PSO: 1, 2, 3, 4, 5, 6, 7

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)
1	Demonstrate proficiency in manipulating matrices, including identifying types of matrices, performing elementary row operations, and determining submatrices, leading to a deep understanding of matrix algebra fundamentals.	PO: 1, 2, 4, 5, 6 PSO: 1, 2, 3, 4, 5, 6, 7	U	F, C, P	L
2	Gain a comprehensive understanding of vector spaces, including concepts of vectors, linear independence, and dependence, enabling them to analyze and manipulate vectors in various mathematical contexts.	PO: 1, 2, 4, 5, PSO: 1, 2, 3, 4, 5, 6, 7	An	F, P	L
3	Demonstrate competency in eigenvalue analysis, including computing characteristic equations, determining eigenvalues and eigenvectors, and applying the Cayley-Hamilton Theorem, leading to the understanding of diagonalization and diagonalization of symmetric matrices.	PO: 1, 2, 4, 5, PSO: 1, 2, 3, 4, 5, 6, 7	U	F, C, P	L
4	Acquire proficiency in numerical methods for solving algebraic and transcendental equations, such as the Regula Falsi method, Newton-Raphson method, and approximate solution techniques like Horner's method, providing them with tools for practical problem-solving in various mathematical scenarios.	PO: 1, 2, 4, 5, PSO: 1, 2, 3, 4, 5, 6, 7	E	C, P	L
5	Learn to apply advanced techniques such as tridiagonalization, QR-factorization, and the least square method to solve matrix eigenvalue problems and linear simultaneous equations, fostering their ability to apply mathematical concepts to real-world problems.	PO: 1, 2, 4, 5, PSO: 1, 2, 3, 4, 5, 6, 7	Ap	F, C, M	L

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO 4	PS O5	PS O6	PS O 7	PS O 8	PO1	PO2	PO3	PO4	PO5	PO6	PO 7

CO 1	3	3	2	1	1	1	2	-	1	3	-	1	1	1	-
CO 2	3	3	2	1	1	1	2	-	1	3	-	1	1	-	-
CO 3	3	3	2	1	1	1	2	-	1	3	-	1	1	-	-
CO 4	3	3	2	1	1	1	2	-	1	3	-	1	1	-	-
CO 5	3	3	2	1	1	1	2	-	1	3	-	1	1	-	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓			✓
CO 4		✓		✓
CO 5		✓		✓

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Mar Ivanios College (Autonomous)

Discipline	**MATHEMATICS**				
Course Code	MIUK2MDCMAT156.1				
Course Title	**Data Interpretation and Logical Reasoning**				
Type of Course	MDC				
Semester	II				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	3	3 hours	-	-	3
Pre-requisites	Basic High School Mathematics.				
References	1. Nishit K Sinha, Data Interpretation for CAT, Pearson, Noida, 2023. 2. Nishit K Sinha, Logical Reasoning for CAT, Pearson, Noida, 2023.				
Course Summary					

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Data Interpretation**	**15**
	1	Introduction to Data Interpretation, Developing the skills, Data sufficiency, Logical Venn diagrams, Tabulation, Bar Graphs, Pie Chart, Line Graphs, Radar Graphs, Mixed Graphs, Caselets. Practising and Mastering Data Interpretation through exercises. (Foundation/Moderate/Advanced Exercises)	

II	**Logical Reasoning**		**10**
	2	Logical Reasoning: Linear Arrangement, Circular Arrangement, Tabular Arrangement, Logical links, Group formation, syllogism, coding-decoding, logic and data-based reasoning. Practical Exercises.	
III	**Analytical and Verbal Reasoning**		**20**
	3	Analytical Reasoning: Blood relation, Directions decision making, Input-output, cubes and dice, Series (letter, number and mixed), Boolean logic. Verbal Reasoning: Statement and Assumptions, Statement and Conclusions, Statement and Arguments, Statement Course of action, Cause and Effect, Theme detection. Practical Exercises.	

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand different methods to represent data and acquire skills to classify and interpret them and solve the related problems.	U	PSO-1,2,3,5
CO-2	Understand the different types of logical reasoning problems and acquire ability to solve them.	U	PSO 1,2,3,5
CO-3	Understand the analytical reasoning and verbal reasoning problems and acquire ability to solve them.	U	PSO 1,2,3,5
CO-4	Acquire expertise to perform successfully well in data interpretation and reasoning part of competitive examinations.	Ap	PSO 1,2,3,5

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Note: 1 or 2 COs/module

Name of the Course: Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/ PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
1	Understand different methods to	PO	U	P	L/T	

	represent data and acquire skills to classify and interpret them and solve the related problems.	1,2,5				
2	Understand the different types of logical reasoning problems and acquire ability to solve them.	PO 1,2,5	U	P	L/T	
3	Understand the analytical reasoning and verbal reasoning problems and acquire ability to solve them.	PO 1,2,5	U	P	L/T	
4	Acquire expertise to perform successfully well in data interpretation and reasoning part of competitive examinations.	PO 1,2,5	Ap	P	L/T	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO 4	PS O5	PS O6	PSO 7	PSO 8	PO1	PO2	PO3	PO4	PO5	PO 6	PO7
CO 1	3	2	3		3				3	3			2		
CO 2	3	2	3		3				3	3			2		
CO 3	3	2	3		3				3	3			2		
CO 4	3	2	3		3				3	3			2		

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	☐	☐	☐	☐
CO 2	☐	☐	☐	☐
CO 3	☐	☐	☐	☐
CO 4	☐	☐	☐	☐

SEMESTER III

Mar Ivanios College (Autonomous)

Discipline	**MATHEMATICS**				
Course Code	MIUK3DSCMAT200.1				
Course Title	**Advanced Calculus**				
Type of Course	DSC				
Semester	III				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	Basic Calculus				
Course Summary	The summary of the course gives an outline of the core content areas typically found in an advanced calculus course, providing students with a deeper understanding of mathematical analysis and its applications across various disciplines. Understanding each topics is crucial for advanced studies in mathematics, as well as applications in science, engineering, economics, and other disciplines where systems involve multiple variables and dimensions.				
Text	**H Anton, I Bivens, S Davis, *Calculus*, 10th Edition, John Wiley & Sons.** **References:** 1. G. B. Thomas, R. L. Finney, *Calculus*, 9th Edition, Addison-Weseley Publishing Company. 2. J. Stewart, *Calculus with Early Transcendental Functions*, 7th Edition, Cengage India Private Limited. 3. G. A. Jones, J. M. Jones, *Elementary Number Theory*, Springer				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Conics**	**15**
	1	Conic sections: definitions and examples	1
	2	equations of parabolas in standard position	1
	3	equations of ellipses in standard position	1
	4	equations of hyperbolas in standard position	1
	5	rotation of axes; second-degree equations at standard positions	2
	6	asymptotes of hyperbolas	1
	7	translating conics	1
	8	reflections of conics	1
	9	applications	1
	10	rotation of axes and eliminating the cross-product term from the equation of a conic	2
	11	polar equations of conics	3
II		**Functions of two or more variables**	**15**
	1	Level Curves & Level Surfaces	1
	2	Limits along curves	1
	3	Open and closed sets, general limits of functions of two variables	1
	4	Continuity	1
	5	Extensions to three variables	1
	6	Partial derivatives of functions of two variables, the partial derivative functions, partial derivative notation,	2
	7	Implicit partial differentiation,	2
	8	Partial derivatives and continuity,	2
	9	Differentiability, Differentiability and Continuity, Differentials.	2
	10	Chain rules for partial derivatives	2
III		**Multiple Integrals**	**15**
	1	Extrema, Bounded sets,	1
	2	The Extreme-Value Theorem, Finding Relative Extrema,	3
	3	The Second Partials test, Finding Absolute Extrema on Closed and Bounded sets,	2
	4	Extremum Problems With Constraints	1
	5	Lagrange Multipliers, Three Variables and One Constraint.	3
	6	Double Integrals – Volume, Evaluating Double Integrals	3
	7	Properties of Double Integrals	2
		Multivariable Calculus	**15**
	1	Traces Of Surfaces	1

IV	2	The Quadric Surfaces	2
	3	Translations of Quadric Surfaces	2
	4	Reflections of Surfaces in 3-space.	2
	5	Definition of a Triple Integral,	1
	6	Properties, Definition of A Triple Integral,	1
	7	Evaluating Triple Integrals Over More General Regions,	2
	8	Volume Calculated as a Triple Integral.	2
	9	Jacobians in two variables.	2

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	to get the awareness of co-ordinate system in real life	C, U	PSO-1,2,5,7
CO-2	Study the fundamental facts in Functions of two or more variables.	R, U	PSO-2,5,6
CO-3	Learn to evaluate multiple integrals and get a knowledge on calculus.	Ap, R	PSO-3,6
CO-4	Learn to get the awareness of Multivariable calculus	U, R	PSO-2,6
CO-5	Develop expertise and skills in the use of mathematical software and computational tools and applying them in each module.	A, E	PSO-6

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/ PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
1	to get the awareness of co-ordinate system in real life		C, U		L	
2	Study the fundamental facts in Functions of two or more variables.		R, U		L	
3	Learn to evaluate multiple integrals and get a knowledge		Ap, R		L	

	on calculus.					
4	Learn to get the awareness of Multivariable calculus		U, R		L	
5	Develop expertise and skills in the use of mathematical software and computational tools and applying them in each module.		A, E		L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	1	2	-	1	-	3	-	2	3	1	3	1	-	-	-
CO 2	3	-	1	-	-	2	-	1	2	-	-	-	-	-	-
CO 3	-	-	1	-	2	-	-	-	1	2	-	-	-	-	-
CO 4	-	-	2	3	-	-	-		2	1	-	-	-	-	-
CO 5	-	1	-	-	-	-	2		1	-	2	-	-	-	-
CO 6	-	-	-	2	-	3	-	-	3	2	-	-	-	-	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓	✓		✓
CO 3	✓			✓
CO 4		✓		✓
CO 5		✓		✓
CO 6	✓		-	

Mar Ivanios College (Autonomous)

Discipline	**MATHEMATICS**				
Course Code	MIUK3DSCMAT201.1				
Course Title	**Mathematics for Physical Sciences - III**				
Type of Course	DSC				
Semester	III				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-	-	4
Pre-requisites	Elementary Matrix theory, Differentiation, Vectors and Series				
Text Book	**Texts:** Text I : B.S. Grewal, *Higher Engineering Mathematics*, 42nd Edition, Khanna Publishers. Text II : Anton, I Bivens, S Davis. Calculus, 10th Edition, John Wiley & Sons **References:** 1. K. F. Riley, M. P. Hobson, S. J. Bence, *Mathematical Methods for Physics and Engineering*, 3rd Edition, Cambridge University Press. 2. George. B. Afken, Hans. J. Weber, Frank. E. Harris,				

	Mathematical Methods for Physicists, 7th Edition, Academic Press. 3. Mary L. Boas, *Mathematical Methods in the Physical Sciences*, Third Edition, John Wiley &Sons. 4. Erwin Kreyszig,*Advanced Engineering Mathematics*, 10thEdition, Wiley-India.
Course Summary	The course covers a comprehensive range of topics in Differential equaion, Fourier series and Fourier transforms. Matrices and determinants are reviewed. Concept of Eigen values are introduced. Properties of Eigen values are given(only statements), Eigen vectors are introduced. Calculation of Eigen vectors.Cayley Hamilton theorem is applied. Diagonal form of a matrix, Reduction to Diagonal form. Differential equations are introduced. Solving differential equations. Exact differential equation and its are studied. Equation reducible to exact form. Order and degree of differential equations are studied. Equations of first order and higher degree are given. Clairaut's equation are introduced. Complementary function and Particular integral are studied. Linear dependence of solution. Introduction to vector valued functions. We can move to derivatives of such functions. Vector equations of tangent lines to graphs and derivatives of dot and cross products of functions are to be discussed; while results on integration may be avoided. Directional derivatives and vector operator Gradient are studied. Fourier series and Fourier transform are studied.

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Linear Algebra**	**8**
	1	Introduction to Determinants and Matrices, Eigen Values, Properties of Eigen Values (Statements only), Eigen vectors	5
		Cayley-Hamilton Theorem (Statement only), Reduction to Diagonal Form.	3
	[The topics in this section can be found in Chapter I ; Sections 2.12,		

	2.13, 2.14, 2.15, 2.16 of the Text I]		
II	**Ordinary Differential Equations & Vector Differentiation**		**17**
	2	Definitions, Operator D, Rules for finding Complementary function, Rules for finding the Particular integrals.	10
		After an introduction to vector valued functions in Section 12.1, we can move to derivatives of such functions in Section 12.2.Derivatives of dot and cross product of functions are to be discussed. Section 13.6 will provide material on Directional derivative and Gradient.	7
	[The topics in this module can be found in Chapter 13 Sections 13.1 to 13.10 of Text. 1] **(The topics in this module can be found in Chapter 12; sections 12.1, 12.2 and Chapter 13; section 13.6 of Text. II)**		
III	**Abstract Algebra**		**15**
	3	Introduction and Examples, Binary operations, Groups and Subgroups (only statements of theorems). Cyclic groups (Only statements of the theorems except Theorem 6.1) Groups of Permutations (exclude the section Cayley's Theorem)	
	[The topics in this module can be found in Chapter 1 Sections 1.1, 1.2, 1.4, 1.5, 1.6, Chapter II Section 8 of Text III.)		
IV	**Fourier Series and Fourier Transform**		**20**
	4	Introduction, Euler's Formulae (without proof), Conditions for a Fourier Expansion, Functions having Points of Discontinuity, Change of Interval, Even and Odd Functions, Half Range Series,	15
		Fourier Transforms, Properties of Fourier Transforms(Statements only)	5
	[The topics in this module can be found in Chapter 10 [sections 10.1 to 10.7] and Chapter 22[sections22.4, 22.5]of the Text I.]		

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Master the concept of Eigen values and Eigen vectors. Calculation of Eigen vectors. Gain the understanding of Cayley Hamilton theorem. Apply diagonalisation.	R	PSO1,3
CO-2	Understanding differential equation. Develop	Ap,	PSO2,5

	competence in solving differential equation. Understanding different type of differential equations and its solution. Gain the concept of linear dependence.		
CO-3	Gain the concept of vector functions. Able to derive vector functions. Gain the concept of directional derivative. Understanding to use the operator Gradient.	An	PSO3,5
CO-4	Gain the concept Fourier series, calculation of Fourier series. Master the properties of Fourier series. Gain the idea of half range series.	U	PSO1,2
CO-5	Gain the concept of Fourier Transform. Calculation of Fourier transform. Understanding properties of Fourier transform.	E	PSO1,7

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	**CO**	**PO /PSO**	**Cognitive Level**	**Knowledge Category**	**Lecture (L)/ Tutorial (T)**	**Practical (P)**
CO-1	Master the concept of Eigen values and Eigen vectors. Calculation of Eigen vectors. Gain the understanding of Cayley Hamilton theorem. Apply diagonalisation.	PSO1,3	R	F, C		
CO-2	Understanding differential equation. Develop competence in solving differential equation. Understanding different type of differential equations and its solution. Gain the concept of linear dependence.	PSO2,5	Ap,	P		
CO-3	Gain the concept of vector functions. Able to derive vector functions. Gain the concept of directional derivative. Understanding to use the operator Gradient.	PSO3,5	An			
CO-4	Gain the concept Fourier series, calculation of Fourier series. Master the properties of Fourier series. Gain the idea of half range series.	PSO1,2	U	R, U		
CO-5	Gain the concept of Fourier Transform. Calculation of Fourier transform. Understanding properties of Fourier transform.	PSO1,7	E	F, C		

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PS O7	PS O8	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	1	3	2	2	2	3	2	1	2	3	3	3	3	2	2
CO 2	3	2	2	3	3	2	3	3	1	3	2	2	2	1	2
CO 3	3	1	1	3	1	3	3	2	2	3	1	1	3	2	1
CO 4	1	3	2	2	1	3	1	3	2	2	3	3	2	1	3
CO 5	2	3	2	1	3	2	1	3	1	3	2	2	2	3	2
CO 6	1	3	2	2	1	3	1	3	2	2	3	3	2	1	3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓
CO 6	✓	✓	-	✓

Mar Ivanios College (Autonomous)

Discipline	**MATHEMATICS**				
Course Code	MIUK3DSCMAT202.1				
Course Title	**Mathematics for Life Sciences - III**				
Type of Course	DSC				
Semester	III				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-	-	4
Pre-requisites	1. Basic High School Mathematics 2.				
Course Summary	This course provides a comprehensive exploration of essential concepts in data analysis and statistical inference. Beginning with data representation techniques such as bar diagrams, histograms, ogives, and pie charts, students gain a solid foundation in visualizing data. Measures of central tendency and dispersion, including mean, median, mode, standard deviation, and variance, equip students with tools to understand the distribution of data. Correlation and regression analysis deepen understanding of relationships between variables. Probability theory is covered extensively, including events, conditional probability, and random variables, leading to discussions on common distributions like binomial, Poisson, and normal distributions. Statistical inference techniques, including hypothesis testing and ANOVA, provide students with the skills to draw meaningful conclusions from data				

	and make informed decisions.
Text	Myra L. Samuels, Jeffery A. Witmer, Andrew A. Schaffner, *Statistics for Life Sciences*, 5th edition, PEARSON. Chapter 1: Sections 1.1 – 1.3 Chapter 2: Sections 2.1 – 2.9 Chapter 3: Sections 1.1 – 3.7 Chapter 4: Sections 4.1 – 4.5 Chapter 5: Sections 5.1 – 5.2 Chapter 6: Sections 6.1 – 6.7 Chapter 7: Sections 7.1 – 7.5 Chapter 11: Sections 11.1 – 11.7 Chapter 12: Sections 12.1 – 12.3
References	1. S. T. Tan, *Finite Mathematics for the Managerial, Life and Social Sciences*, 9th Edition, Cengage Learning. 2. Glenn Ledder, *Mathematics for the Life Sciences*, Springer. 3. Raina S. Robeva, James R. Kirkwood, Robin L. Davies, Leon S. Farhy, Michael L. Johnson, Boris P. Kovatchev, and Marty Straume, *An Invitation to Bio mathematics*, ELSEVIER. 4. Myra L. Samuels, Jeffery A. Witmer, *Statistics for Life Sciences*, 3rd edition, Prentice Hall.

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Introduction to Statistics**	**15**
	1	Data representation- bar diagrams,	2
		histogram,	1
		ogives,	1
		pi- charts,	1
	2	Central tendency measures- mean, median, mode, Arithmetic Mean,	5
	3	Dispersion Measures- SD and variance, Correlation and regression.	5
II		**Introduction to probability**	**15**
	1	Events, probability of an event, types of events,	4

	2	addition theorem,	2
	3	conditional probability,	2
		multiplication theorem,	2
	4	Random variables, discrete and continuous random variables.	5
III	**Standard Probability Distributions**		**15**
	1	Binomial distribution,	5
	2	Poison distribution,	5
	3	Normal distribution	5
IV	**ANOVA**		**15**
	1	Statistical Inference - Testing,	6
	2	One way ANOVA,	5
	3	two-way ANOVA	4

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Demonstrate proficiency in representing data using various graphical methods such as bar diagrams, histograms, ogives, and pie charts, enhancing their ability to visualize and interpret data effectively.	R	PSO: 1, 2, 3, 4, 5, 6, 7, 8
CO-2	Comprehend measures of central tendency (mean, median, mode) and dispersion (standard deviation and variance), enabling them to describe the spread and distribution of data accurately.	U	PSO: 1, 2, 3, 4, 5, 6, 7, 8
CO-3	Master fundamental concepts of probability theory, including events, conditional probability, and random variables (both discrete and continuous), allowing them to analyse uncertain events and make informed decisions.	Ap	PSO: 1, 2, 3, 4, 5, 6, 7, 8
CO-4	Apply the knowledge of common probability distributions such as the binomial, Poisson, and normal distributions to model and analyse real-world phenomena accurately.	R	PSO: 1, 2, 3, 4, 5, 6, 7, 8

CO-5	Analyse relationships between variables through correlation and regression analysis, enabling them to quantify and interpret associations within data sets effectively.	C	PSO: 1, 2, 3, 4, 5, 6, 7, 8
CO-6	Develop the ability to perform hypothesis testing and conduct ANOVA tests (both one-way and two-way), empowering them to draw meaningful conclusions from data and make statistical inferences about populations.	C	PSO: 1, 2, 3, 4, 5, 6, 7, 8

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Note: 1 or 2 COs/module

Name of the Course: Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)
1	Demonstrate proficiency in representing data using various graphical methods such as bar diagrams, histograms, ogives, and pie charts, enhancing their ability to visualize and interpret data effectively.	PO: 1, 2, 3, 4, 5, 6, 7, 8 / PSO: 1, 2, 3, 4, 5, 6, 7, 8	R	F, C	L
2	Comprehend measures of central tendency (mean, median, mode) and dispersion (standard deviation and variance), enabling them to describe the spread and distribution of data accurately.	PO: 1, 2, 3, 4, 5, 6, 7, 8 / PSO: 1, 2, 3, 4, 5, 6, 7, 8	U	F, C, P	L
3	Master fundamental concepts of probability theory, including events, conditional probability, and random variables (both discrete and continuous), allowing them to analyse uncertain events and make informed decisions.	PO: 1, 2, 3, 4, 5, 6, 7, 8 / PSO: 1, 2, 3, 4, 5, 6, 7, 8	Ap	F, C, M	L
4	Apply the knowledge of common probability distributions such as the binomial, Poisson, and normal distributions to model and analyse real-world phenomena accurately.	PO: 1, 2, 3, 4, 5, 6, 7, 8 / PSO: 1, 2, 3, 4, 5, 6, 7, 8	R	C, M	L
5	Analyse relationships between variables through correlation and regression analysis, enabling them to quantify and interpret associations within data sets effectively.	PO: 1, 2, 3, 4, 5, 6, 7, 8 / PSO: 1, 2, 3, 4, 5, 6, 7, 8	C	C, P	L
6	Develop the ability to perform hypothesis testing and conduct ANOVA tests (both	PO: 1, 2, 3, 4, 5, 6, 7, 8	C	C, P	L

	one-way and two-way), empowering them to draw meaningful conclusions from data and make statistical inferences about populations.	/ PSO: 1, 2, 3, 4, 5, 6, 7, 8			

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO 4	PS O5	PS O6	PS O 7	PS O 8	PO1	PO2	PO3	PO4	PO5	PO6	PO 7
CO 1	3	3	2	1	1	1	2	2	1	3	1	1	1	1	1
CO 2	3	3	2	1	1	1	2	2	1	3	1	1	1	1	1
CO 3	3	3	2	1	1	1	2	2	1	3	1	1	1	1	1
CO 4	3	3	2	1	1	1	2	2	1	3	1	1	1	1	1
CO 5	3	3	2	1	1	1	2	2	1	3	1	1	1	1	1
CO 6	3	3	2	1	1	1	2	2	1	3	1	1	1	1	1

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓			✓
CO 4		✓		✓
CO 5		✓		✓
CO 6			✓	

Mar Ivanios College (Autonomous)

<table>
<tr><td>Discipline</td><td colspan="5">MATHEMATICS</td></tr>
<tr><td>Course Code</td><td colspan="5">MIUK3DSCMAT203.1</td></tr>
<tr><td>Course Title</td><td colspan="5">Basic Operations Research</td></tr>
<tr><td>Type of Course</td><td colspan="5">DSC</td></tr>
<tr><td>Semester</td><td colspan="5">III</td></tr>
<tr><td>Academic Level</td><td colspan="5">200 - 299</td></tr>
<tr><td rowspan="2">Course Details</td><td>Credit</td><td>Lecture per week</td><td>Tutorial per week</td><td>Practical per week</td><td>Total Hours/Week</td></tr>
<tr><td>4</td><td>3 hours</td><td>-</td><td>2 hours</td><td>5</td></tr>
<tr><td>Pre-requisites</td><td colspan="5">1. Linear Equations
2. Inequalities</td></tr>
<tr><td>Course Summary</td><td colspan="5">This course at the undergraduate level typically covers mathematical modelling, optimization techniques, and decision-making methods to solve complex problems in operations and decision sciences. It covers formulation of LPP, methods of transportation, assignment problems and project management techniques like CPM and PERT. This course equips students with quantitative problem-solving skills and analytical tools necessary for optimizing processes, making informed decisions, and improving efficiency in various organizational settings and preparing students for careers in operations research, management consulting, and related fields.</td></tr>
<tr><td>Prescribed Text</td><td colspan="5">Ravindran - Philips - Solberg: Operations Research- Principles and Practice</td></tr>
<tr><td>Reference Textbooks</td><td colspan="5">1. Hamdy A Taha: Operations Research: An Introduction (10th Edition)
2. Kanti Swarup, P. K. Gupta, Man Mohan: Operations</td></tr>
</table>

	Research 3. J K Sharma: Operations Research - Theory and Applications

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Linear Programming**	**15**
	1	Formulation of Linear Programming models	5
	2	Graphical solution of Linear Programs in two variables	5
	3	Linear Programs in standard form - basic variable - basic solution- basic feasible solution-feasible solution	5
		[The topics to be discussed in this module can be found in Chapter 2 of the prescribed text]	
II		**Simplex method**	**15**
	4	Solution of a Linear Programming problem using simplex method (Since Big- M method is not included in the syllabus, avoid questions in simplex method with constraints of $\geq$ or = type).	15
		[The topics to be discussed in this module can be found in Chapter 2 of the prescribed text]	
III		**Transportation Problems**	**15**
	5	Linear programming formulation - Initial basic feasible solution (Vogel's approximation method/ North-west corner rule)	6
	6	-degeneracy in basic feasible solution - Modified distribution method – optimality test.	4
		Standard assignment problems - Hungarian method for solving an assignment problem.	5
		[The topics to be discussed in this module can be found in Chapter 3 of the prescribed text]	
IV		**Project Management**	**15**
	7	Activity -dummy activity - event - project network, CPM (solution by network analysis only),	9
	8	PERT.	6

		[The topics to be discussed in this module can be found in Chapter 3 Section 7 of the prescribed text]	
		Use CAS wherever possible	

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Formulate LPP and Solve LPP using Graphical method	Ap, An, E, C	PSO 1,2,3
CO-2	Determine the solution of LPP using Simplex method	Ap, An, E	PSO 1,2,3
CO-3	Use Vogel's Approximation method and North West corner method to solve the transportation problem and Hungarian method to solve assignment problems	An, Ap,E	PSO 1,2,3
CO-4	Apply the techniques of CPM and PERT to solve the real-life problems	Ap, An, E, C	PSO 1,2,3

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Note: 1 or 2 COs/module

Name of the Course: Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/ PSO	Cognitive Level	Knowledge Category	Lecture (L) / Tutorial (T)	Practical (P)
1	Formulate LPP and Solve LPP using Graphical method	PO 1,2/PSO 1,2,3	Ap, An, E, C	F, C	L	
2	Determine the solution of LPP using Simplex method	PO 1,2/PSO 1,2,3	Ap, An, E	F, C	L	
3	Use Vogel's Approximation method and North West corner method to solve the transportation problem and Hungarian method to solve assignment problems	PO 1,2/PSO 1,2,3	An, Ap,E	F, C	L	
4	Apply the techniques of CPM and PERT to solve the real-life problems	PO 1,2/PSO 1,2,3,4,5	Ap, An, E, C	F, C	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	3	3	2	2	1	1	1	3	3	-	2	2	1	2
CO 2	3	3	3	2	2	1	1	1	3	3	1	-	2	1	1
CO 3	3	3	3	3	1	1	1	2	3	3	-	-	1	2	2
CO 4	3	3	3	3	3	2	1	1	3	3	1	1	2	2	3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3		✓		✓
CO 4		✓		✓

Mar Ivanios College (Autonomous)

Discipline	**MATHEMATICS**				
Course Code	MIUK3DSCMAT204.1				
Course Title	**Statistics and Optimization**				
Type of Course	DSC				
Semester	III				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-	-	4
Pre-requisites	1. Basic Statistics 2. Linear Equations				
Course Summary	This course provides a comprehensive introduction to probability and statistics, focusing on both theoretical concepts and practical applications. Students will learn about data representation, measures of central tendency, and spread, laying the foundation for statistical analysis. Topics include experiments, events, permutations, combinations, and random variables, with a detailed study of probability distributions such as binomial, Poisson, and normal distributions. Students will explore methods for random sampling, point estimation of parameters, confidence intervals, and hypothesis testing, gaining skills in decision-making and quality control techniques. Advanced topics include regression analysis, curve fitting, correlation, and nonparametric tests. Additionally, the course introduces the fundamentals of Markov chains, including state and transition probabilities, multi-period transition probabilities, and				

	steady-state conditions, along with applications in various fields. The course concludes with an introduction to linear programming, covering important definitions, graphical solution methods, special cases, and the simplex method for solving optimization problems. Through theoretical learning and practical exercises, students will develop a strong foundation in probability, statistics, and optimization techniques essential for data analysis and decision-making in diverse domains.
Text	1. Advanced Engineering Mathematics, Erwin Kreyszig, Wiley International Edition, 9th edition. 2. Operations Research Theory and applications, J K Sharma, MacMillan, 3rd edition. Chapter 24: Sections 24.1 – 24.9 of Text 1 Chapter 25: Sections 25.1 – 25.9 of Text 1 Chapter 18: Sections 18.1 – 18.7 of Text 2 Chapter 3: Sections 3.1 – 3.4 Chapter 4: Sections 4.1 – 4.6 of Text 2.
References	1. Edwin K. P. Chong, Stanislaw H. Zak, An Introduction to Optimization, Fourth Edition, John Wiley & Sons. 2. Sheldon M. Rooss, Stochastic Processes, 2nd Edition, John Wiley and Sons, 1996. 3. H A Taha, Operations Research – An Introduction, Prentice Hall, 7th edition, 2006.

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Data Analysis and Probability**	**15**
	1	Data Representation, Average, spread	2
	2	Experiments, events, outcomes, permutations and combinations	2
	3	Random Variables, probability distributions, Mean and Variance of a distribution	3
	4	Binomial, Poisson, Normal distributions	8
II		**Mathematical Statistics**	**15**
	1	Random Sampling,	1
		Point Estimation of parameters,	2
	2	Confidence Interval,	2
		Testing of Hypothesis, Decisions, Quality control,	2

	3	Acceptance Sampling, Goodness of fit, Chi-square test,	2
		Nonparametric tests,	3
	4	Regression, Curve fitting, Correlation	3
III		**Markov Chains**	**15**
	1	Introduction and Characteristics of a Markov Chain,	3
		Applications of Markov Analysis,	2
	2	State and Transition probabilities,	3
	3	Multi Period Transition probabilities,	3
	4	Steady state conditions, Absorbing states	4
IV		**Linear Optimization**	**15**
	1	Introduction, Important Definitions	2
	2	Graphical Solution methods of LP Problem	3
	3	Special cases in linear programming	2
	4	Simplex method, types of solutions	8

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Demonstrate proficiency in analysing data, including representing data, calculating measures of central tendency and spread, and understanding various probability distributions such as binomial, Poisson, and normal distributions.	R, U, Ap	PSO: 1, 2, 3, 4, 5, 6, 7
CO-2	Gain a deep understanding of probability theory and random variables, enabling them to analyse experiments, events, outcomes, and perform calculations of mean and variance for distributions.	R, U, Ap, An	PSO: 1, 2, 3, 4, 5, 6, 7
CO-3	Develop skills in inferential statistics, including point estimation of parameters, constructing confidence intervals, and hypothesis testing, facilitating informed decision-making and quality control in various scenarios.	E, R, U, Ap	PSO: 1, 2, 3, 4, 5, 6, 7
CO-4	Acquire techniques for data analysis, including regression analysis, curve fitting, and correlation, allowing them to model relationships between variables and make predictions based on observed data.	E, Ap, An, C	PSO: 1, 2, 3, 4, 5, 6, 7
CO-5	Demonstrate competency in analysing Markov chains, including understanding state and transition probabilities, multi-period transition probabilities, steady-state conditions, and applications of Markov analysis in various fields.	U, Ap, An	PSO: 1, 2, 3, 4, 5, 6, 7
CO-6	Gain proficiency in linear programming, including	U, Ap, An,	PSO: 1, 2,

	understanding important definitions, graphical solution methods, and the simplex method for solving optimization problems, providing them with tools for solving real-world optimization problems efficiently.	E	3, 4, 5, 6, 7

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)
1	Demonstrate proficiency in analysing data, including representing data, calculating measures of central tendency and spread, and understanding various probability distributions such as binomial, Poisson, and normal distributions.	PO: 1, 2, 4, 5, 6 PSO: 1, 2, 3, 4, 5, 6, 7	R, U, Ap	F, C, P	L
2	Gain a deep understanding of probability theory and random variables, enabling them to analyse experiments, events, outcomes, and perform calculations of mean and variance for distributions.	PO: 1, 2, 4, 5 / PSO: 1, 2, 3, 4, 5, 6, 7	R, U, Ap, An	F, C	L
3	Develop skills in inferential statistics, including point estimation of parameters, constructing confidence intervals, and hypothesis testing, facilitating informed decision-making and quality control in various scenarios.	PO: 1, 2, 4, 5 / PSO: 1, 2, 3, 4, 5, 6, 7	E, R, U, Ap	C, P, M	L
4	Acquire techniques for data analysis, including regression analysis, curve fitting, and correlation, allowing them to model relationships between variables and make predictions based on observed data.	PO: 1, 2, 4, 5 / PSO: 1, 2, 3, 4, 5, 6, 7	E, Ap, An, C	P, M	L
5	Demonstrate competency in analysing Markov chains, including understanding state and transition probabilities, multi-period transition probabilities, steady-state conditions, and applications of Markov analysis in various fields.	PO: 1, 2, 4, 5 / PSO: 1, 2, 3, 4, 5, 6, 7	U, Ap, An	F, C, P	L
6	Gain proficiency in linear programming, including understanding important definitions, graphical solution methods, and the simplex method for solving optimization problems, providing them with tools for solving real-world	PO: 1, 2, 4, 5 / PSO: 1, 2, 3, 4, 5, 6, 7	U, Ap, An, E	C, P	L

	optimization problems efficiently.				

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO 4	PS O5	PS O6	PS O 7	PS O 8	PO1	PO2	PO3	PO4	PO5	PO6	PO 7
CO 1	3	3	2	1	1	1	2	-	1	3	-	1	1	1	-
CO 2	3	3	2	1	1	1	2	-	1	3	-	1	1	-	-
CO 3	3	3	2	1	1	1	2	-	1	3	-	1	1	-	-
CO 4	3	3	2	1	1	1	2	-	1	3	-	1	1	-	-
CO 5	3	3	2	1	1	1	2	-	1	3	-	1	1	--	-
CO 6	3	3	2	1	1	1	2	-	1	3	-	1	1		-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓			✓
CO 4		✓		✓
CO 5		✓		✓
CO 6		✓		✓

Mar Ivanios College (Autonomous)

Discipline	**MATHEMATICS**				
Course Code	MIUK3DSEMAT205.1				
Course Title	**Elementary Number Theory and Cryptography**				
Type of Course	DSE				
Semester	III				
Academic Level	200 – 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-	-	4
Pre-requisites					
References	1. David M Burton, Elementary Number Theory, McGraw Hill Education (India) Private Limited, 2011, Reprint 2023. 2. Thomas Koshy, Elementary Number Theory with Applications (2nd ed), Academic Press, 2007. 3. Gareth A Jones and J. Mary Jones, Elementary Number Theory, Springer, 1998. Indian Reprint 2009. 4. Joseph H Silverman, A Friendly Introduction to Number Theory (4th ed), Pearson India Education Services, 2019. 5. T. M. Apostol, Introduction to Analytic Number Theory, Springer New York, 1998. 6. Kenneth H. Rosen, Elementary Number Theory (6th ed), Pearson Education, 2015. 7. K. Ireland and M. Rosen, A Classical Introduction to Modern Number Theory, Springer, 1998. 8. J. H. Silverman, Jill Pipher, Jeffrey Hoffstein, An Introduction to				

	Mathematical Cryptography, Springer, 2008.
Course Summary	This course introduces basic properties of numbers, congruences, and three related milestone theorems. Various applications of number theory, with emphasis on coding, cryptography, and primality testing are also elaborated.

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Division Theorem, GCD, and primes**	**15**
	1	The division algorithm, Base-b representations and operations in non-decimal basis, Prime and Composite numbers, Infinitude of primes, distribution of primes, the greatest common divisor, methods to find the gcd, Euclidean algorithm, fundamental theorem of arithmetic and canonical decomposition method, linear Diophantine equations and their solutions.	
II		**Congruences and applications**	**15**
	2	Congruences, Linear congruences, Applications of congruences-Divisibility tests, Hashing functions, pseudo random numbers, Modular designs, Check digits, p-queens puzzle, round robin tournaments, perpetual calendar- Systems of linear congruences, Chine Remainder theorem for pairwise relatively prime moduli and its extension to arbitrary moduli.	
III		**Three classical milestone theorems and applications**	**15**
	3	Fermat's Theorem, Euler's theorem, Wilsons Theorem, Their Applications, Pseudo Primes, Arithmetic functions- Multiplicative functions, Euler's phi function, tau and sigma functions, mobius function.	
IV		**Introduction to Cryptography**	**15**
	4	Quadratic residues and reciprocity, the idea of public key cryptography, From Caesar cypher to Public Key cryptography, Affine cyphers, Hill cyphers, Exponentiation cyphers, RSA cryptosystem, The Knapsack cryptosystem. Cryptographic protocols, Key Exchange, Digital Signatures.	

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the division algorithm and apply it to find gcd of numbers and to solve linear Diophantine equations,	U, Ap	1,2,3,4,5
CO-2	Acquire expertise in the application of congruences and solution of system of congruences	U, Ap, C	1,2,3,4,5
CO-3	Apply Fermat's little Theorem, Euler's theorem, and Wilson's Theorem to solve various number theoretic problems, and understand some basic Arithmetic functions	U, Ap	1,2,3,4,5
CO-4	Apply number theoretic concepts to solve cryptographic problems and acquire expertise in innovative coding techniques	U, Ap, C	1,2,3,4,5,6

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1	Understand the division algorithm and apply it to find gcd of numbers and to solve linear Diophantine equations,	PO 1,2,5,6	F, C, P	C, P	L/T	
2	Acquire expertise in the application of congruences and solution of system of congruences	PO 1,2,5,6	F, C, P	C, P	L/T	
3	Apply Fermat's little Theorem, Euler's theorem, and Wilson's Theorem to solve various number theoretic problems, and understand some basic Arithmetic functions	PO 1,2,5,6	F, C, P	C, P	L/T	
4	Apply number theoretic concepts to solve cryptographic	PO 1,2,5,6	F, C, P	C, P	L/T	

	problems and acquire expertise in innovative coding techniques					

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	2	3	3	2	2				3	3			2	2	
CO 2	2	3	3	2	2				3	3			2	2	
CO 3	2	3	3	2	2				3	3			2	2	
CO 4	2	3	3	2	2	3			3	3			2	3	

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓	✓	✓
CO 2	✓	✓	✓	✓
CO 3	✓	✓	✓	✓
CO 4	✓	✓	✓	✓

SEMSETER IV

Mar Ivanios College (Autonomous)

Discipline	**MATHEMATICS**				
Course Code	MIUK4DSCMAT250.1				
Course Title	**Linear Algebra**				
Type of Course	DSC				
Semester	IV				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-	-	4
Pre-requisites	1. Elementary Matrix Theory				
Course Summary	The course covers a comprehensive range of topics in linear algebra and its applications. It begins with the study of various types of matrices, including partitioned matrices and their submatrices. Students learn elementary row operations and how they are used to manipulate matrices, leading to the understanding of echelon forms and the computation of inverses using these operations. The course delves into the characterization of invertible matrices and their significance in solving systems of linear equations, both homogeneous and non-homogeneous. Vectors are introduced, along with concepts of linear independence, dependence, and their role in forming vector spaces. Linear models in economics and engineering are explored, highlighting the practical applications of linear algebra. Further topics include null spaces, column spaces, and the fundamental properties of linear transformations, including their matrix				

	representations. The course emphasizes the importance of bases, dimension, and rank in understanding the structure of vector spaces and linear transformations. Eigenvalues and eigenvectors are introduced, leading to discussions on diagonalization and the Cayley-Hamilton theorem. Applications in computer graphics demonstrate how these concepts are used in practical scenarios. Orthogonality and inner products are studied, along with techniques like the Gram-Schmidt process for orthogonalization. Special attention is given to diagonalization of symmetric matrices and their significance in various fields. Finally, quadratic forms are introduced, completing the course's coverage of linear algebra and its diverse applications.
Text	David C. Lay, *Linear Algebra and its Applications*, Fourth Edition, Addison-Wesley. Chapter 1: Sections 1.1 – 1.10, Chapter 2: Sections 2.1 – 2.4, 2.8, 2.9 Chapter 4: Sections 4.1 – 4.7 Chapter 5: Sections 5.1 – 5.4 Chapter 6: Sections 6.1 – 6.4 Chapter 7: Sections 7.1 – 7.2
References	1. Gilbert Strang, *Linear Algebra and its Applications*, Fourth Edition. 2. Thomas Banchoff, John Wermer, *Linear Algebra Through Geometry*, Second Edition, Springer. 3. Sterling K. Berberian, *Linear Algebra*, Oxford University Press, 1992.

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Matrices**	**15**
	1	Types of matrices, submatrices	2
		Elementary row operations	2
		Echelon form	3
	2	Inverse of a matrix using elementary operations	3
		Characterizations of invertible matrices	2

		Partitioned matrices	3
II	**Linear systems Equations and their consistency**		**15**
	1	Systems of Linear equations	1
		Non-homogeneous systems	3
		Homogeneous systems	2
	2	Vectors	2
		Linear independence and dependence of vectors	4
	3	Linear Models in Economics and Engineering	3
III	**Vector Spaces**		**15**
	1	Vector Spaces	1
		Null Spaces	1
		Column spaces	1
	2	Linear Transformations	1
		Linearly independent sets	1
		Bases	1
		Dimension	1
		Rank	1
	3	Matrix of linear transformations	1
		Change of basis	1
	4	Characteristic equations	1
		Eigen values and eigen vectors	2
		Cayley Hamilton Theorem	1
		Application to computer graphics	1
IV	**Diagonalization and quadratic forms**		**15**

	1	Diagonalization	2
		Eigen vectors and linear transformations	1
		Applications	1
	2	Inner products	1
		Orthogonal sets	1
		Gram – Schmidt Process	2
	3	Diagonalization of symmetric matrices	3
		Quadratic forms	4

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	perform various operations on matrices, including elementary row operations, determining submatrices, identifying echelon forms, and computing inverses using elementary operations	R, Ap, E, C	1, 2, 3,4 5, 6, 7
CO-2	gain an understanding of the properties and characteristics of matrices, including invertible matrices, partitioned matrices, and the relationship between matrices and systems of linear equations	Ap, E	1, 2, 3,4 5, 6, 7
CO-3	develop competence in vector spaces, understanding concepts such as linear independence, dependence, bases, dimension, rank, null spaces, and column spaces. They will also gain proficiency in linear transformations, including matrix representations of linear transformations and change of basis	Ap, An, E	1, 2, 3,4 5, 6, 7
CO-4	apply the concepts learned in the course to computer graphics, understanding how matrices and linear transformations are used to represent geometric transformations, such as translation, rotation, scaling, and shearing	Ap, An, E, C	1, 2, 3,4 5, 6, 7
CO-5	master the concepts of eigenvalues and eigenvectors, including their calculation, interpretation, and applications in diagonalization, linear transformations, and the Cayley-Hamilton theorem	Ap, An, C, E	1, 2, 3,4 5, 6, 7
CO-6	gain proficiency in inner products, orthogonal sets, and the Gram-Schmidt process. They will also learn about diagonalization of symmetric	Ap, AN, E, C	1, 2, 3,4 5, 6, 7

	matrices and applications of orthogonalization techniques in solving systems of equations and quadratic forms.		

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)
1	perform various operations on matrices, including elementary row operations, determining submatrices, identifying echelon forms, and computing inverses using elementary operations	PO: 1, 2, 4, 5, 6 / PSO: 1, 2, 3,4 5, 6, 7	R, Ap, E, C	F, C, P	L
2	gain an understanding of the properties and characteristics of matrices, including invertible matrices, partitioned matrices, and the relationship between matrices and systems of linear equations	PO: 1, 2, 4, 5, 6 / PSO: 1, 2, 3,4 5, 6, 7	Ap, E	F, C, P	L
3	develop competence in vector spaces, understanding concepts such as linear independence, dependence, bases, dimension, rank, null spaces, and column spaces. They will also gain proficiency in linear transformations, including matrix representations of linear transformations and change of basis	PO: 1, 2, 4, 5, 6 / PSO: 1, 2, 3,4 5, 6, 7	Ap, An, E	F, P	L
4	apply the concepts learned in the course to computer graphics, understanding how matrices and linear transformations are used to represent geometric transformations, such as translation, rotation, scaling, and shearing	PO: 1, 2, 4, 5, 6 / PSO: 1, 2, 3,4 5, 6, 7	Ap, An, E, C	F, P	L
5	master the concepts of eigenvalues and eigenvectors, including their calculation, interpretation, and applications in diagonalization, linear transformations, and the Cayley-Hamilton theorem	PO: 1, 2, 4, 5, 6 / PSO: 1, 2, 3,4 5, 6, 7	Ap, An, C, E	F, C, P	L
6	gain proficiency in inner products, orthogonal sets, and the Gram-Schmidt process. They will also learn about diagonalization of symmetric matrices and applications of orthogonalization	PO: 1, 2, 4, 5, 6 / PSO: 1, 2, 3,4 5, 6, 7	Ap, AN, E, C	F, C, P	L

	techniques in solving systems of equations and quadratic forms.				

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO 4	PS O5	PS O6	PS O 7	PS0 8	PO1	PO2	PO3	PO4	PO5	PO6	PO 7
CO 1	3	3	2	1	1	1	2	-	1	3	-	1	1	1	-
CO 2	3	3	2	1	1	1	2	-	1	3	-	1	1	1	-
CO 3	3	3	2	1	1	1	2	-	1	3	-	1	1	1	-
CO 4	3	3	2	1	1	1	2	-	1	3	-	1	1	1	-
CO 5	3	3	2	1	1	1	2	-	1	3	-	1	1	1	-
CO 6	3	3	2	1	1	1	2	-	1	3	-	1	1	1	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓			✓
CO 4		✓		✓
CO 5		✓		✓
CO 6			✓	

Mar Ivanios College (Autonomous)

Discipline	**MATHEMATICS**				
Course Code	MIUK4DSCMAT251.1				
Course Title	**Vector Calculus**				
Type of Course	DSC				
Semester	IV				
Academic Level	200 -299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	1. Knowledge about Vectors 2. Differentiating and integrating multivariable functions				
Course Summary	This course is intended to get the knowledge of vectors ,its various operations, Sketching ideas, vector functions , Vector calculus and its various applications. The targeted audience of this course is the undergraduate mathematics students.				
Prescribed Text	H Anton, I Bivens, S Davis. Calculus, 10th Edition, John Wiley& Sons				
	1) Elena Nardi, Paola lannonne. How to Prove it: A brief guide for teaching Proof to Year 1 mathematics undergraduates, University of East Anglia, Centre for Applied Research in Education 2) G B Thomas, R L Finney. Calculus, 9th Edition, Addison-				

	Wesley Publishing Company 3) J Stewart. Calculus with Early Transcendental Functions, 7th Edition, Cengage India Private Limited.

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Vector Calculus**	**15**
	1	Vectors, dot products, Projections, Cross product, parametric equations of lines, Planes in 3-Space 11.2,11.3,11.4,11.5,11.6	15
II		**Types of Vectors and its Applications**	**15**
	2	Introduction to vector valued functions using parametric curves in the three-dimensional space, limits, continuity and derivatives of vector valued functions, geometric interpretation of the derivative, basic rules of differentiation of such functions, derivatives of vector products. Integrating vector functions, length of an arc of a parametric curve, change of parameter, arc length parametrizations Various types of vectors that can be associated to a curve such as unit vectors, tangent vectors, binormal vectors 12.1,12.2,12.3, 12.4	9
	3	Curvature,Various formulae for curvature, the geometrical interpretation of curvature 12.5,12.6	4
III		**Vector Fields**	**15**
	4	Directional derivative ,gradient ,Vector fields and their graphical representation, various type of vector fields (inverse-square, conservative), potential functions	5
	5	Divergence, curl, the operator: Laplacian. Integrating a function along a curve (line integrals), integrating a vector field along a curve, defining work done as a line integral, line integrals along piecewise-smooth curves, integration of vector fields and independence of path, fundamental theorem of line	10

		integrals, line integrals along closed paths, test for conservative vector fields 15.1,15.2,15.3	
IV	**Application of Vector Calculus**		**15**
	6	Green's theorem and applications. Defining and evaluating surface integrals, their applications, orientation of surfaces, evaluating flux integrals, The divergence theorem, Gauss' Law, Stoke's theorem, applications of these theorems. 15.4,15.5,15.6,15.7,15.8	15

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the concept of vectors and demonstrate various vectors and sketch the planes in 3 D space	U,Ap	PSO-1,2,3,6
CO-2	Differentiate and integrate various vector valued functions	An	PSO-1,2,3,4
CO-3	Evaluate Line integrals	E	PSO-1,2,3
CO-4	Apply the concepts of vector calculus for evaluating surface integrals	Ap, E	PSO-1,2,3,4,6

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Note: 1 or 2 COs/module

Name of the Course: Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
1	Understand the concept of vectors and demonstrate various vectors and sketch the planes in 3 D space	PO 1,2 /PSO-1,2,3,6	U,Ap	F, C, P,M	L	
2	Differentiate and integrate various	PO 1,2 /PSO-	An	C,M	L	

	vector valued functions	1,2,3,4				
3	Evaluate Line integrals	PO 1,2/PSO-1,2,3	E	M	L	
4	Apply the concepts of vector calculus for evaluating surface integrals	PO 1,2 6/PSO-1,2,3,4,6	Ap, E	C, M	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**
CO 1	3	3	3	-	-	3	-	-	3	3	-	2	-	1	-
CO 2	3	3	3	3	-	-	1	1	3	3	-	-	2	-	1
CO 3	3	3	3	2	1	-	-	-	3	3	-	-	-	-	-
CO 4	3	3	3	3	-	3	2	1	3	3	-	-	-	3	-

Correlation Levels:

Level	**Correlation**
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4		✓		✓

Mar Ivanios College (Autonomous)

Discipline	**MATHEMATICS**				
Course Code	MIUK4DSEMAT252.1				
Course Title	**Theory of Equations**				
Type of Course	DSE				
Semester	IV				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-	-	4
Pre-requisites	1: Basic High School Algebra 2: Differentiation of elementary functions				
Course Summary	This course offers a comprehensive exploration of complex numbers, covering basic algebraic operations, absolute value, conjugates, and inequalities. Students learn to compute square roots of complex numbers and explore their geometric representation alongside De Moivre's Theorem. Topics extend to nth roots of complex numbers, roots of unity, and polynomial operations including multiplication and synthetic division. Algebraic equations, imaginary roots, and their relation to coefficients are discussed, along with special cases like multiple roots and upper limits. Techniques such as Rolle's theorem and Sturm's functions aid in root separation and analysis of real roots, while practical applications and problem-solving strategies are emphasized throughout. Symmetric functions are defined, with the fundamental theorem of symmetric functions establishing their importance.				

	Lagrange's solutions for cubic and biquadratic equations are presented, along with the Gaussian Principle. Throughout the course, practical applications and problem-solving techniques are emphasized to deepen understanding and foster mathematical proficiency.
Text	J. V. Uspensky, *Theory of Equations*, McGraw Hill Chapters I, II, III, IV, V, VI, VII, VIII, XI
References	1. Leonard Eugene Dickson, *Elementary Theory of Equations*, First Edition, John Wiley & Sons. 2. Turnbull H. W., *Theory of Equations*, Oliver and Boyd, 1947.

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Complex Numbers and Polynomials in one variable**	**15**
	1	Introduction to complex numbers and basic algebraic operations	1
		Absolute value, Conjugates and related inequalities	1
		Square root of a complex number	1
		Geometric representation of complex numbers	1
	2	De Moivre's Theorem	1
		n^{th} root of a complex number	2
		Roots of unity	1
	3	Multiplication and Synthetic division of polynomials	1
		Remainder Theorem, Horner's Process	1
		Taylor's Theorem	1
		Highest Common divisor of two polynomials	1
	4	Introduction to Algebraic Equations	1
		Identity Theorem	1

		Fundamental Theorem of Algebra	1
II	**More on Algebraic Equations**		**15**
	1	Imaginary roots of equations with real coefficients	1
		Relation between roots and coefficients	3
		Case of multiple roots	1
	2	Upper limit of positive roots	2
		Limit for moduli of roots	1
		Rational roots	2
	3	Cubic Equation: Cardan's Method	2
		Irreducibility case	1
		Biquadratic equations	2
III	**Separation of roots and Sturm's theorem**		**15**
	1	Objective of Separation of roots	1
		Basic Theorems and lemmas without proof	2
	2	Applications of Rolle's theorem	2
		Descarte's rule of signs	2
	3	Equations with real roots	1
		A complete Method of Separating roots	2
	4	Introduction to Sturm's functions	2
		The Sturm's theorem and problems	3
IV	**Approximate roots and Symmetric functions**		**15**
	1	Introduction	1
		The Horner's method	2
	2	Method of contraction	1

		Estimation of error	1
		Method of iteration	2
	3	Definition of symmetric functions – Basic problems	2
		Fundamental theorem of symmetric functions	1
		Practical method - Problems	2
	4	Lagrange's solution of cubic equations	1
		Lagrange's solution of biquadratic equations	1
		The Gaussian Principle	1

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	develop a solid understanding of complex numbers, including their properties, arithmetic operations, and geometric representation, enabling them to manipulate them confidently in mathematical contexts.	R, U, Ap, E	PSO: 1, 2, 3, 4, 5, 6, 7
CO-2	Students will acquire proficiency in algebraic techniques related to complex numbers, including computing square roots, finding nth roots, and performing polynomial operations such as multiplication and synthetic division	R, U, Ap, An	PSO: 1, 2, 3, 4, 5, 6, 7
CO-3	Upon completion of the course, students will be equipped with the tools to analyse algebraic equations, including identifying imaginary roots, understanding their relation to coefficients, and dealing with special cases like multiple roots and upper limits.	E, R, U	PSO: 1, 2, 3, 4, 5, 6, 7
CO-4	Students will gain experience in applying theoretical concepts such as Rolle's theorem, Sturm's functions, and symmetric functions to analyse and solve mathematical problems related to complex numbers and algebraic equations.	E, Ap, An	PSO: 1, 2, 3, 4, 5, 6, 7
CO-5	Upon completion of the course, students will have a thorough understanding of symmetric functions and their significance in mathematics, enabling them to apply them effectively in various problem-solving contexts.	U, Ap, An	PSO: 1, 2, 3, 4, 5, 6, 7
CO-6	By studying Lagrange's solutions for cubic and biquadratic equations, as well as the Gaussian Principle, students will deepen their understanding of advanced mathematical techniques and their applications in solving complex problems.	Ap, An, C	PSO: 1, 2, 3, 4, 5, 6, 7

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)
1	develop a solid understanding of complex numbers, including their properties, arithmetic operations, and geometric representation, enabling them to manipulate them confidently in mathematical contexts.	PO: 1, 2, 4, 5, 6 /PSO: 1, 2, 3, 4, 5, 6, 7	R, U, Ap, E	F, C, P	L
2	Students will acquire proficiency in algebraic techniques related to complex numbers, including computing square roots, finding nth roots, and performing polynomial operations such as multiplication and synthetic division	PO: 1, 2, 4, 5, 6 /PSO: 1, 2, 3, 4, 5, 6, 7	R, U, Ap, An	C, P	L
3	Upon completion of the course, students will be equipped with the tools to analyze algebraic equations, including identifying imaginary roots, understanding their relation to coefficients, and dealing with special cases like multiple roots and upper limits.	PO: 1, 2, 4, 5, 6 /PSO: 1, 2, 3, 4, 5, 6, 7	E, R, U	C, M	L
4	Students will gain experience in applying theoretical concepts such as Rolle's theorem, Sturm's functions, and symmetric functions to analyze and solve mathematical problems related to complex numbers and algebraic equations.	PO: 1, 2, 4, 5, 6 /PSO: 1, 2, 3, 4, 5, 6, 7	E, Ap, An	F, C, M	L
5	Upon completion of the course, students will have a thorough understanding of symmetric functions and their significance in mathematics, enabling them to apply them effectively in various problem-solving contexts.	PO: 1, 2, 4, 5, 6 /PSO: 1, 2, 3, 4, 5, 6, 7	U, Ap, An	F, M	L
6	By studying Lagrange's solutions for cubic and biquadratic equations, as well as the Gaussian Principle, students will deepen their understanding of advanced mathematical	PO: 1, 2, 4, 5, 6 /PSO: 1, 2, 3, 4, 5, 6, 7	Ap, An, C	F, C, P	L

	techniques and their applications in solving complex problems.				

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	3	3	2	1	1	1	2	-	1	3	-	1	1	1	-
CO 2	3	3	2	1	1	1	2	-	1	3	-	1	1	1	-
CO 3	3	3	2	1	1	1	2	-	1	3	-	1	1	1	-
CO 4	3	3	2	1	1	1	2	-	1	3	-	1	1	1	-
CO 5	3	3	2	1	1	1	2	-	1	3	-	1	1	1	-
CO 6	3	3	2	1	1	1	2	-	1	3	-	1	1	1	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓			✓
CO 4		✓		✓
CO 5		✓		✓
CO 6			✓	

.

Mar Ivanios College (Autonomous)

Discipline	**MATHEMATICS**				
Course Code	MIUK4SECMAT253.1				
Course Title	**Python Programming and LaTeX**				
Type of Course	SEC				
Semester	IV				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	3	3 hours	-	-	3
Pre-requisites	1. Basic knowledge of computer 2. Mathematical logic				
Text Book	1. Vernon L. Ceder, *The Quick Python Book*, Second Edition, Manning. 2. Indian TeX Users Group, *LaTeX Tutorials - A Primer*, available online at https://www.tug.org/twg/mactex/tutorials/ltxprimer-1.0.pdf				
Course summary	In this course we introduce a high-level, general-purpose programming language programming language Python and a mathematical typesetting tool LaTeX. We discuss the basics of python through examples from mathematics as a tool to solve mathematical problems. The core part of LaTeX program is included in the course.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Python Programming**	**20**

	1	We begin the discussion by introducing the basics of python. The feature of using python as a calculator, the supporting data types, variables, assignments, expressions, operations, indentation and comments etc. are to be discussed in detail. Then introduces list, tuple, set etc and their features and attributes. The strings, string operations, formatting of strings and related topics are to be discussed in detail. Then we introduce dictionaries too. The control flow elements including if, if- else, if-elif-else and for, while loops etc are discussed with more examples. We introduce the functions and related topics too.	
	The topics are to be discussed based on chapters 3 to 9 of Text1. In chapter 9, only sections 9.1 to 9.5 need to be discussed.		
II	**Typesetting using LaTeX**		**25**
	2	The main topics in this module are following: Typesetting a simple article and compiling it. How spaces are treated in the document. Document layout: various options to be included in the documentclass command, page styles, splitting files into smaller files, breaking line and page, using boxes (like, mbox) to keep text unbroken across lines, dividing document in to parts like frontmatter, mainmatter, backmatter, chapters, sections, etc, cross referencing with and without page number, adding footnotes. Emphasizing words with \emph,\texttt, \textsl, \textit, \underline etc. Basic environments like enumerate, itemize, description, flushleft, flusuright, center, quote, quotation. Controlling enumeration via the enumerate package. Tables: preparing a table and floating it, the longtable environment. Typesetting mathematics: basic symbols, equations, operators, the equation environment and reference to it, the displaymath environment, exponents, arrows, basic functions, limits, fractions, spacing in the mathematics environments, matrices, aligning various objects, multi-equation environments, suppressing numbering for one or more equations, handling long equations, phantoms, using normal text in math mode, controlling font size, typesetting theorems, definitions, lemmas, etc, making text bold in math mode, inserting symbols and environments (array, pmatrix, etc) using the support of GUIs. Figures: Including JPG, PNG graphics with graphicx package, controlling width, height etc., floating figures, adding captions, the wrapfig package. Adding references/bibliography and citing them,	

		using the package hyperref to add and control hypertext links, creating presentations with pdfscreen, creating new commands. Fonts: changing font size, various fonts, math fonts. Spacing: changing line spacing, controlling horizontal, vertical spacing, controlling the margins using the geometry package, fullpage package. Preparing a dummy project with titlepage, acknowledgement, certificates, table of contents (using \tableofcontents), list of tables, table of figures, chapters, sections, bibliography (using the thebibliography environment). This dummy project should contain atleast one example from each of the topic in the syllabus, and should be submitted for internal evaluation before the end semester practical examination.	
	The topics are to be discussed based on Text2.		

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Typeset a report containing Mathematics using LaTeX.	U, Ap	PSO-1,2,3,6
CO-2	Acquire basic programming skill.	U, Ap	PSO-1,3,6,7
CO-3	Understand basics of python programming and use to solve related problems.	U, Ap, C	PSO-1,2,5,6,7

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Note: 1 or 2 COs/module

Name of the Course: Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
1	Typeset a report containing Mathematics using LaTeX.	PO-1,2,6 / PSO-1,2,3,6	U, Ap	P, M	L	P
2	Acquire basic programming skill.	PO-1,2,5 / PSO-1,3,6,7	U, Ap	F, C, P	L	P
3	Understand basics of python programming and use to solve related problems.	PO-2,5,6/ PSO-1,2,5,6,7	U, Ap, C	F, C, P,M	L	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO 4	PS O5	PS O6	PSO 7	PSO 8	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	3	3	-	2	3	2	1	3	3	2	-	1	3	-
CO 2	3	2	3	-	2	3	3	1	3	3	2	1	3	2	-
CO 3	3	3	2	1	3	3	3	1	2	3	2	-	3	3	1

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓

SEMSETER – V

Mar Ivanios College (Autonomous)

<table>
<tr><td>Discipline</td><td colspan="5">MATHEMATICS</td></tr>
<tr><td>Course Code</td><td colspan="5">MIUK5DSCMAT300.1</td></tr>
<tr><td>Course Title</td><td colspan="5">Real Analysis I</td></tr>
<tr><td>Type of Course</td><td colspan="5">DSC</td></tr>
<tr><td>Semester</td><td colspan="5">V</td></tr>
<tr><td>Academic Level</td><td colspan="5">300 - 399</td></tr>
<tr><td rowspan="2">Course Details</td><td>Credit</td><td>Lecture per week</td><td>Tutorial per week</td><td>Practical per week</td><td>Total Hours/Week</td></tr>
<tr><td>4</td><td>4 hours</td><td>-</td><td>-</td><td>4</td></tr>
<tr><td>Pre-requisites</td><td colspan="5">1. Real numbers, Set theory
2. Logic</td></tr>
<tr><td>Course Summary</td><td colspan="5">This course provides a comprehensive overview of real numbers, covering fundamental concepts such as upper and lower bounds, supremum, infimum, maximum, and minimum of a set. It delves into the density of rational and irrational numbers, exploring their distribution within the real number line. The Nested Interval Property is discussed, emphasizing its significance in understanding real number intervals. The course also examines the existence of square roots and the uncountability of the interval (0,1), elucidating Cantor's theorem.

In the realm of sequences, the course addresses the limit of a sequence, diverging sequences, algebraic operations on limits, and the order properties of sequences and limits. Key theorems like the Monotone Convergence Theorem and the Bolzano-Weierstrass Theorem are introduced, alongside techniques such as Cauchy's condensation test for series convergence and various other convergence tests. The Cauchy</td></tr>
</table>

	criterion for series convergence is discussed, as well as rearrangement of absolutely convergent series. Transitioning to set theory, the course covers open and closed sets in $\mathbb{R}$, complements, and the concept of compactness of sets defined using sequential convergence. It explores open covers and compactness, and distinguishes perfect and connected sets within $\mathbb{R}$. Through these topics, students gain a deep understanding of the foundational concepts underpinning real analysis.
Text	Stephen Abbott, *Understanding Analysis*, Second Edition, Springer. Chapter 1: Sections 1.1 – 1.6 Chapter 2: Sections 2.1 – 2.7 Chapter 3: Sections 3.1 – 3.4
References	1. Robert G. Bartle, Donald R. Sherbert, *Introduction to Realm Analysis*, Fourth Edition, John Wiley & Sons. 2. Ajit Kumar, S. Kumaresan, *A Basic Course in Real Analysis*, CRC Press. 3. Sterling K. Berberian, A First Course in Real Analysis, Springer.

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Real Numbers**	**15**
	1	Overview of real numbers	2
	2	upper bounds, lower bounds	2
		Supremum, infimum, maximum and minimum of a set	1
	3	Density of rational numbers and irrational numbers	3
		Nested Interval Property	2
	4	Existence of square roots, uncountability of $(0, 1)$	3
		Cantor's theorem	2
II		**Sequences**	**15**
	1	Limit of a sequence	2

		diverging sequences	2
	2	algebraic operations on limits	3
		order properties of sequences and limits	2
		the Monotone Convergence Theorem	2
	3	sub sequences	2
		the Bolzano -Weierstrass theorem	2
III		**Infinite Series**	**15**
	1	Cauchy's condensation test for convergence of a series	2
	2	various other tests for the convergence series	4
	3	the Cauchy criterion for convergence of a series	3
	4	rearrangement of absolutely convergent series	6
IV		**Topology on *R***	**15**
	1	Open and closed sets in R	3
		Complements	2
	2	Compactness of sets (defined using sequential convergence)	3
		Open covers and compactness	2
	3	perfect and connected sets in R	5

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	analyse and evaluate the properties of real numbers, including their upper and lower bounds, supremum, infimum, maximum, and minimum, and apply these concepts to solve mathematical problems.	R, U, Ap	PSO: 1, 2, 3, 4, 5, 6, 7
CO-2	demonstrate understanding of the density of rational and irrational numbers, and utilize this knowledge to prove the uncountability of certain sets, such as the interval (0,1), using Cantor's theorem.	R, U, Ap, An	PSO: 1, 2, 3, 4, 5, 6, 7
CO-3	apply the Nested Interval Property to analyse intervals	E, R, U, Ap	PSO: 1, 2,

	and their properties, including the existence of square roots within the real number system.		3, 4, 5, 6, 7
CO-4	investigate the behaviour of sequences, including limits, divergence, and the existence of sub sequences, and utilize algebraic operations to manipulate and evaluate limits.	E, Ap, An, C	PSO: 1, 2, 3, 4, 5, 6, 7
CO-5	apply key convergence tests, such as the Monotone Convergence Theorem, the Bolzano-Weierstrass Theorem, and Cauchy's condensation test, to determine the convergence of series and sequences.	U, Ap, An	PSO: 1, 2, 3, 4, 5, 6, 7
CO-6	analyse and manipulate sets in $\mathbb{R}$, including open and closed sets, complements, and compactness, and understand the concepts of perfect and connected sets within the real number system.	Ap, An	PSO: 1, 2, 3, 4, 5, 6, 7

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)
1	analyse and evaluate the properties of real numbers, including their upper and lower bounds, supremum, infimum, maximum, and minimum, and apply these concepts to solve mathematical problems.	PO: 1, 2, 4, 5, 6 / PSO: 1, 2, 3, 4, 5, 6, 7	R, U, Ap	F, C, P	L
2	demonstrate understanding of the density of rational and irrational numbers, and utilize this knowledge to prove the uncountability of certain sets, such as the interval (0,1), using Cantor's theorem.	PO: 1, 2, 4, 5, 6 / PSO: 1, 2, 3, 4, 5, 6, 7	R, U, Ap, An	C, P, M	L
3	apply the Nested Interval Property to analyse intervals and their properties, including the existence of square roots within the real number system.	PO: 1, 2, 4, 5, 6 / PSO: 1, 2, 3, 4, 5, 6, 7	E, R, U, Ap	P, M	L
4	investigate the behaviour of sequences, including limits, divergence, and the existence of sub sequences, and utilize algebraic operations to manipulate and evaluate limits.	PO: 1, 2, 4, 5, 6 / PSO: 1, 2, 3, 4, 5, 6, 7	E, Ap, An, C	F, C, M	L
5	apply key convergence tests, such as the Monotone Convergence Theorem, the Bolzano-Weierstrass Theorem, and Cauchy's condensation test, to determine the convergence of series and sequences.	PO: 1, 2, 4, 5, 6 PSO: 1, 2, 3, 4, 5, 6, 7	U, Ap, An	F, C P	L

6	analyse and manipulate sets in $\mathbb{R}$, including open and closed sets, complements, and compactness, and understand the concepts of perfect and connected sets within the real number system.	PO: 1, 2, 4, 5, 6 / PSO: 1, 2, 3, 4, 5, 6, 7	Ap, An	F, M	L

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO 4	PS O5	PS O6	PS O 7	PS O 8	PO1	PO2	PO3	PO4	PO5	PO6	PO 7
CO 1	3	3	2	1	1	1	2	-	1	3	-	1	1	1	-
CO 2	3	3	2	1	1	1	2	-	1	3	-	1	1	1	-
CO 3	3	3	2	1	1	1	2	-	1	3	-	1	1	1	-
CO 4	3	3	2	1	1	1	2	-	1	3	-	1	1	1	-
CO 5	3	3	2	1	1	1	2	-	1	3	-	1	1	1	-
CO 6	3	3	2	1	1	1	2	-	1	3	-	1	1	1	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓			✓
CO 4		✓		✓
CO 5		✓		✓
CO 6			✓	

Mar Ivanios College (Autonomous)

Discipline	**MATHEMATICS**				
Course Code	MIUK5DSCMAT301.1				
Course Title	**Complex Analysis**				
Type of Course	DSC				
Semester	V				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-	-	4
Pre-requisites	1. The Algebra of Complex Numbers 2. Point Representation of Complex Numbers 3. Polar form of Complex Numbers 4. De Moivre's theorem				
	Text: Dennis G Zill, Patric D Shanahan, *A First Course in Complex Analysis with Applications*, Jones and Bartlett Publishers (2003). References 1. James Ward Brown and Ruel V Churchill, *Complex Variables And Applications*, Eighth Edition, McGraw Hill International Edition. 2. Edward B. Saff, Arthur David Snider, *Fundamentals of Complex Analysis with Applications to Engineering and Science*, 3rd Edition, Pearson Education India. 3. Erwin Kreyszig, *Advanced Engineering Mathematics*, 10th Edition, Wiley-India.				

	4. Schaum's Outline Series, *Complex Variables*.
Course Summary	The course commences by exploring fundamental concepts such as complex functions, exponential functions, exponential representation of complex functions, polar coordinates, and parametric curves in the complex plane. It delves into detailed discussions on limits, continuity, differentiability, and the properties of analytic functions. Additionally, it covers elementary functions and integration in the complex plane, Taylor series, Laurent series, zeros and poles, residues, Cauchy's residue theorem, Some consequence of residue theorem and Evaluation of Real Trigonometric Integrals are discussed in detail. The course culminates with a module on Conformal Mapping, which deals with linear mapping and conformal mapping.

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Analytic Functions**	**15**
	1	Function, real and imaginary parts of a complex function, Exponential function, Exponential form of a complex function	3
	2	polar coordinates	1
	3	parametric curves in Complex Plane	3
	4	Limits, continuity.	2
	5	branch cut	1
	6	Differentiability and Analyticity,	2
	7	Cauchy - Riemann Equation, Harmonic Functions	3
	The topics to be discussed in this module can be found in *Chapter 2, Sections 2.1, 2.2 2.6.1, 2.6.2 (Excluding "Example 6 - discontinuity of principal square root function, Branches, Branch cuts, Points and Applications") and chapter 3, sections 1-3 of* **the text.**		
II		**Complex Integration**	**15**
	8	Exponential and Logarithmic functions,	3

	9	Complex powers, Trigonometric and Hyperbolic Functions.	3
	10	Complex Integrals	3
	11	Cauchy - Goursat Theorem,	3
	12	Cauchy's Integral Formula and Their Consequences	3
	The topics to be discussed in this module can be found in *Chapter 4 - Sections 4.1, 4.2, 4.3 (excluding trigonometric equations, modulus, zeros, analyticity, trigonometric mapping), 4.3.2. and Chapter 5 - Sections 5.1, 5.2 (excluding the proof of a bounding theorem), 5.3 (excluding the proof of Cauchy Theorem, Theorem 5.3, Theorem 5.4), 5.4 (Some conclusions 5, 6, 7 - proof need not be discussed and exclude example 5), 5.5.1 (excluding proof of Theorems 5.10, 5.15, 5.16)of* **the text.**	
III	**Evaluation of Real Integrals**		**15**
	13	Sequence and Series, Talyors' Series	2
	14	Laurent Series	3
	15	Zeros and Poles, residues	3
	16	Cauchy's Residue Theorem	2
	17	Some consequence of residue theorem, Evaluation of Real Trigonometric Integrals	5
	The topics to be discussed in this module can be found in *Chapter 6, Sections 6.1 (excluding the proof of theorems); Section-6.2; Section-6.3 (excluding the proof of Theorem 6.10); Section-6.4, 6.5, 6.6.1, 6.6.2 (excluding the topic Indented Contours) of* **the text.**		
IV	**Conformal Mapping**		**15**
	18	Linear Mappings	4
	19	Conformal Mapping	6
	20	Linear Fractional Transformation	5
	The topics to be discussed in this module can be found in *Chapter 2, Section 2.3 and Section 7.1 (excluding the proof of Theorems 7.1, 7.2 and the topic Conformal Mappings Using Tables); Section 7.2 (excluding the proof of Theorem 7.3 and the topic Linear Fractional*		

	Transformations as Matrices)of **the text.**

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the limits, continuity and differentiability of complex functions.	R, U, Ap, E	PSO-1,2,3, 4, 7, 8
CO-2	Analyze analytic functions and other elementary functions	R, U, Ap, E	PSO-1,2,3, 4, 7, 8
CO-3	Apply contour integration, Cauchy's theorem and Cauchy's integral formula.	R, U, Ap, E	PSO-1,2,3, 4,5, 7, 8
CO-4	Understand Series representation of complex numbers, Singular points, Zeroes and Residue of Complex functions.	R, U, Ap, E	PSO-1,2, 3, 4, 7, 8
CO-5	Apply Taylor's Series, Laurent Series and Residue Theorem.	R, U, Ap, E	PSO-1,2,3,4,5,7, 8
CO-6	Understand Conformal mapping, Linear Fractional Transformation and Cross ratio.	R, U, Ap, E	PSO-1,2, 3, 4, 7, 8

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Note: 1 or 2 COs/module

Name of the Course: Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
1	Understand the limits, continuity and differentiability of complex functions.	PO-1,2, 4,5, 6, 7	R, U, Ap, E	F, C	L	
2	Analyze analytic functions and other elementary functions	PO-1,2, 4,5, 6, 7	R, U, Ap, E	F,P, M	L	
3	Apply contour integration, Cauchy's theorem and Cauchy's integral formula.	PO-1,2, 4,5, 6, 7	R, U, Ap, E	F, C, P	L	
4	Understand Series representation of complex numbers, Singular points, Zeroes and Residue of Complex functions.	PO-1,2, 4,5, 6, 7	R, U, Ap, C	F, P, M	L	
5	Apply Taylor's Series, Laurent Series and Residue Theorem.	PO-1,2, 4,5, 6, 7	R, U, An, C	P, M	L	
6	Understand Conformal mapping, Linear Fractional	PO-1,2,	R, U,	F, P,	L	

	Transformation and Cross ratio.	4,5, 6, 7	An, C	M		

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	2	3	2	-	-	2	1	3	3	-	1	3	2	1
CO 2	3	2	3	2	-	-	2	1	3	3	-	1	3	2	1
CO 3	3	2	3	2	2		2	1	3	3	-	1	3	2	1
CO 4	3	2	3	2	-	-	2	1	3	3	-	1	3	2	1
CO 5	3	2	3	2	2		2	1	3	3	-	1	3	2	1
CO 6	3	2	3	2	-	-	2	1	3	3	-	1	3	2	1

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓
CO 6	✓	✓		✓

Mar Ivanios College (Autonomous)

Discipline	**MATHEMATICS**				
Course Code	MIUK5DSCMAT302.1				
Course Title	**Abstract Algebra – Group Theory**				
Type of Course	DSC				
Semester	V				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-	-	4
Pre-requisites	1. Basics of Set Theory 2. Properties of Integers 3. Modular Arithmetic				
Text Book	**Text:** Joseph Gallian, ***Contemporary Abstract Algebra***, 9th Edition, Cengage Learning **References:** 1. D S Dummit, R M Foote, *Abstract Algebra*, 3rd Edition, Wiley 2. I N Herstein, *Topics in Algebra*, Vikas Publications				
Course Summary	This course aims to give a basic and concrete idea of Group Theory. The topics are discussed with enough motivation through examples. We introduce groups, infinite and finite groups, subgroups, cyclic and permutation groups etc. The group isomorphisms and automorphisms are also discussed in detail. The partition of groups using cosets and factor groups are also discussed in the course.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Group theory: Introduction**	**15**
	1	Introducing groups using properties of integers and symmetries of a square etc. Also motivating the students using the applications in Chemistry - the study if symmetries of molecules using groups.	5
	2	Definition and examples of groups, Elementary properties of groups.	5
	3	Finite groups and subgroups.	5
	The topics to be discussed are from chapters 1 to 3 of the Text		
II		**Cyclic Groups and Permutations**	**15**
	4	Cyclic groups- Definition, examples, properties, and classification.	7
	5	Definition and operations on permutations, Cycle notation and properties.	7
	6	Application on Check digits shall be discussed as assignment. (excluded from end semester examination)	1
	The topics to be discussed are from chapters 4 and 5 of the Text		
III		**Isomorphisms and Cosets**	**15**
	7	Definition, examples, and properties of isomorphism.	6
	8	Automorphisms	3
	9	Cayley's Theorem	1
	10	Motivation, definition, and properties of cosets.	5
	The topics to be discussed are from chapters 6 and 7 of the Text		
IV		**Lagrange's Theorem and Factor Groups**	**15**
	11	Lagrange's Theorem and consequences.	5
	12	Application of cosets to permutation groups, rotations of cube and soccer ball	2
	13	Normal subgroups and factor groups	5
	14	Applications of Factor groups	2
	15	Internal direct products	1

	The topics to be discussed are from chapters 7 and 9 of the Text

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the foundations in the theory of groups and acquire ability to solve related problems.	U, Ap, E	PSO -1,2,3
CO-2	Understand various properties of cyclic groups, their subgroups, and aquire ability to apply the results to solve problems related to cyclic groups.	R, U, Ap, E	PSO -1,2,3
CO-3	Understand the idea of isomorphism of groups and acquire ability to detect whether two groups are isomorphic or non-isomorphic. To understand the classic result of Cayley on finite groups.	R, U, Ap, E	PSO -1,2,3
CO-4	Understand the idea of cosets, normal subgroups, factor groups, and acquire ability to solve related problems.	R, U, Ap, E	PSO-1,2,3,5

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Note: 1 or 2 COs/module

Name of the Course: Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
1	Understand the foundations in the theory of groups and acquire ability to solve related problems.	PO- 1, 2/PSO -1,2,3	U, Ap, E	F, C	L	
2	Understand various properties of cyclic groups, their subgroups, and acquire ability to apply the results to solve problems related to cyclic groups.	PO- 1,2/ PSO - 1,2,3	R, U, Ap, E	F, C, M	L	
3	Understand the idea of isomorphism of groups and acquire ability to detect whether two groups are isomorphic or non-isomorphic. To understand the classic result of Cayley on	PO 1,2,6/ PSO - 1,2,3	R, U, Ap, E	F, C, M	L	

	finite groups.					
4	Understand the idea of cosets, normal subgroups, factor groups, and acquire ability to solve related problems.	PO 1,2,6/ PSO-1,2,3,5	R, U, Ap, E	C, M	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO 4	PS O5	PS O6	PSO 7	PSO 8	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	3	3	-	1	2	1	1	3	3	-	2	2	1	1
CO 2	3	3	3	1	-	-	-	-	3	3	2	2	1	-	1
CO 3	3	3	3	2	-	1	-	1	3	3	1	-	2	3	-
CO4	3	3	3	-	3	-	1	-	3	3	2	-	1	3	1

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3		✓		✓
CO 4		✓		✓

Mar Ivanios College (Autonomous)

Discipline	**MATHEMATICS**				
Course Code	MIUK5DSEMAT303.1				
Course Title	**Numerical Methods**				
Type of Course	**DSE**				
Semester	V				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-	-	4
Pre-requisites					
Text Book	1. Introductory Methods of Numerical Analysis, S.S Sastry, Prentice Hall India, New Delhi 2. Erwin Kreyszig. Advanced Engineering Mathematics, 10th Edition, Wiley-India				
Course Summary	The course begins with a discussion on general concepts in Numerical Analysis. Then discusses some classical methods to determine roots of algebraic and transcendental equations. Interpolation and methods of numerical differentiation and integration are also discussed. Finally we discuss some methods to solve ODEs and system of linear equations.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I			**20**
	1	General concepts in Numerical analysis: Introduction, Floating-Point Form of Numbers, Round off, Loss of Significant Digits, Errors of Numeric Results. Solution of Equations by Iteration: Bisection Method, Newton-Raphson Method for Solving Equations f(x) = 0, Generalized Newton's Method, Order of an Iteration Method, Speed of Convergence, Convergence of Newton's Method.	
II	**Interpolation, Numerical Differentiation and Integration**		**15**
	2	Interpolation: Lagrange Interpolation for unevenly spaced points and Newton's Divided Difference Interpolation. Newton's Forward Difference and Back-ward Difference Interpolation Numerical Differentiation using forward differences. Numerical Integration: Trapezoidal Rule, Simpson's Rule of Integration.	
III	**Numerical solution of ODEs**		**10**
	3	Numerical Solution of Ordinary Differential Equations, Methods for First-Order ODEs, Picard's Iteration method, Euler's method (Numeric Method), Improved Euler Method, Runge-Kutta Methods (RK Methods) of fourth order.	
IV	**Numerical Methods ion Linear Algebra**		**15**
	4	Numerical Methods in Linear Algebra Linear Systems: Gauss Elimination : Matrix Inversion, Gauss-Jordan Elimination. Matrix Inversion. Linear Systems: Solution by Iteration, Gauss-Seidel Iteration Method, Jacobi Iteration	

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understanding various functions and learning techniques of differentiation involving these functions, review inverse trigonometric functions including their derivatives, learn about hyperbolic functions, understanding derivatives of hyperbolic functions.	Ap, U, R	PSO1,3
CO-2	Gain an understanding of derivatives of trigonometric functions, gain proficiency in finding derivatives of different trigonometric functions, master the concept of chain rule and implicit differentiation including their calculation.	An, E, U	PSO2,3
CO-3	Master the properties of functions, understanding important theorems in differentiation, gain the idea of partial differentiation, understanding various techniques of partial differentiation, master the concept of partial differentiation.	Ap, C, R R, C, U	PSO2,6
CO-4	Understanding different types of matrices, gain the concept of linear system of equations, row operations, row echelon form, computing solutions of linear system of equations.	An, C, U	PSO3,7
CO-5	Gain an idea of functions, including limits and continuity, master the concept of Differentiation, understanding various techniques of differentiation like product rule and quotient rule.	Ap, R, C	PSO2,8

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Note: 1 or 2 COs/module

Name of the Course: Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)

1	Understanding various functions and learning techniques of differentiation involving these functions, review inverse trigonometric functions including their derivatives, learn about hyperbolic functions, understanding derivatives of hyperbolic functions.	PSO1,3	Ap, U, R	F, C, P	L	
2	Gain an understanding of derivatives of trigonometric functions, gain proficiency in finding derivatives of different trigonometric functions, master the concept of chain rule and implicit differentiation including their calculation.	PSO2,3	An, E, U	P,C, P	L	
3	Master the properties of functions, understanding important theorems in differentiation, gain the idea of partial differentiation, understanding various techniques of partial differentiation, master the concept of partial differentiation.	PSO2,6	Ap, C, R R, C, U	F,C, P	L	
4	Understanding different types of matrices, gain the concept of linear system of equations, row operations, row echelon form, computing solutions of linear system of equations.	PSO3,7	An, C, U	F,P,C	L	
5	Gain an idea of functions, including limits and continuity, master the concept of Differentiation, understanding various techniques of differentiation like product rule and quotient rule.	PSO2,8	Ap, R, C	F,P,C	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	**PSO 7**	**PSO 8**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
CO 1	2	1	3	2	1	3	2	1	2	2	3	3	3	2	3
CO 2	2	3	2	3	3	3	3	3	1	2	2	2	2	3	2
CO 3	3	3	1	1	1	2	2	2	3	1	1	3	3	1	1
CO 4	1	1	3	3	2	1	1	3	2	1	3	1	2	1	3
CO 5	2	3	1	1	3	2	2	3	2	3	2	2	3	3	2
CO 6	2	1	3	2	1	3	2	1	2	2	3	3	3	2	3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3		✓		✓
CO 4		✓		✓
CO5		✓		✓

Mar Ivanios College (Autonomous)

Discipline	**MATHEMATICS**				
Course Code	MIUK5DSEMAT304.1				
Course Title	**Graph Theory**				
Type of Course	**DSE**				
Semester	V				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-	-	4
Pre-requisites	1. Basics of set theory				
	Text 1: Frank Harary, Graph Theory, Narosa publishing house, New Delhi. **Text 2 :** John Clark, Derek Allan Holton. A first look at Graph Theory, World Scientific. References 1. J A Body, U S R Murthy. Graph Theory with Applications, The Macmillan Press 2. Robin J Wilson. Introduction to Graph Theory 5th edition, Prentice Hall 3. Gary Chartrand and Ping Zhang, *Introduction to Graph Theory*,New Delhi, New York: Tata McGraw-Hill Pub. Co., 2006.				
Course Summary	The course begins by laying the groundwork with an exploration of fundamental Graph Theory concepts. From there, we delve into the study of concepts such as trees, bridges, spanning trees, cut vertices, and connectivity, providing a comprehensive understanding of each. Further topics include a detailed study of Euler Tours and Hamiltonian Cycles. Finally, the course concludes with an in-depth				

	module on planar graphs, focusing on Planar Graphs, Colorability and Digraph and connectedness to provide a well-rounded understanding of this field.

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Basics**	**15**
	1	Varieties of graphs, walk and connectedness	3
	2	Degrees, Problem of Ramsey, Operation on graphs	4
	3	cut points, bridges and blocks	4
	4	The adjacency matrix, The incidence matrix	4
	[The topics to be discussed in this module can be found in Chapter 2, 3 & Chapter 13 of text 1]		
II		**Trees and connectivity**	**15**
	5	Definitions and Simple Properties of trees, Bridges	4
	6	Spanning Trees	3
	7	Cut Vertices and Connectivity	4
	8	Kruskal's algorithm, Prim's algorithm,	4
	[The topics to be discussed in this module can be found in Chapter 2 Sections 1- 4 of test 2]		
III		**Traversability**	**15**
	9	Eulerian graphs, TheChinese Postman Problem	7
	10	Hamiltonian Graphs, The Travelling Salesman Problem	8
	[The topics to be discussed in this module can be found in Chapter 7 of text 1 and Chapter 3 Sections 2- 4 of text 2].		
IV		**Planar graphs**	**15**
	11	Plane and Planar Graphs,	2

	12	Euler's Formula, Kuratowski's Theorem	5
	13	The chromatic number	5
		The five color Theorem, The four color conjecture	1
	14	Digraph and connectedness	2
	[The topics to be discussed in this module can be found in Chapter 11, chapter 12 and 16 of text 1]		

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	To define and understand the fundamental concepts of graph theory	R, U	PSO-1,2,3, 4, 7, 8
CO-2	To apply the concepts and theorems that are treated in the course for problem-solving and proofs	R, U, Ap	PSO-1,2,3, 4, 5, 7, 8
CO-3	To develop better understanding of the subject so as to use these ideas skilfully insolving real world problems	R, U, Ap,	PSO-1,2,3, 4,5, 7, 8

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Note: 1 or 2 COs/module

Name of the Course: Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO1	To define and understand the fundamental concepts of graph theory	PO-1,2, 4,5, 6, 7	R, U, Ap, E	F, C	L	
CO 2	To apply the concepts and theorems that are treated in the course for problem-solving and proofs	PO-1,2, 4,5, 6, 7	R, U, Ap, E	P, M	L	
CO3	To develop better understanding of the subject so as to use these ideas skilfully in	PO-1,2,	R, U,	P, M	L	

	solving real world problems	4,5, 6, 7	Ap, E			

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	3	3	3	-	-	2	2	3	3	-	1	3	2	1
CO 2	3	3	3	3	2	-	2	3	3	3	-	1	3	2	1
CO 3	3	3	3	3	2	-	2	3	3	3	-	1	3	2	1

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓

Mar Ivanios College (Autonomous)

Discipline	**MATHEMATICS**				
Course Code	MIUK5SECMAT305.1				
Course Title	**Data Analysis using Python**				
Type of Course	SEC				
Semester	V				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	3	3 hours	-	-	3
Pre-requisites	1. Basic Python programming 2. Basics of data analysis				
Text Books	1. Wes McKinney, *Python for Data Analysis*, 2nd Edition, O'Reilly 2. Online tutorials and documentation for Python, NumPy, Pandas, Matplotlib, and Seaborn				
Course Summary	In this course we discuss the essentials of the advanced python modules Numpy, pandas, and matplotlib. Using these tools we discuss some data handling techniques and visualize data and analyse data.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Numpy and Pandas**	**10**
	1	In this unit we discuss the basics of the python modules numpy, pandas, and matplotlib. The major topics are:	

		The NumPy ndarray, Universal Functions, Oriented Programming with Arrays (exclude plotting), File Input and Output with Arrays, Linear Algebra, Pseudorandom Number Generation. Introduction to pandas Data Structures, Essential Functionality, Summarizing and Computing Descriptive Statistics.	
	The topics are to be discussed based on chapters 4 to 5 of Text1.		
II	**Handling Data**		**20**
	2	In this unit we discuss the loading and manipulation of data. The topics are: Reading and Writing Data in Text Format, Binary Data Formats, Interacting with Web APIs, Interacting with Databases, Handling Missing Data, Data Transformation, String Manipulation, Hierarchical Indexing, Combining and Merging Datasets, Reshaping and Pivoting	
	The topics are to be discussed based on chapters 6, to 8 of Text1.		
III	**Plotting and Visualization and Time series**		**15**
	3	In this module we visualize and analyse data using different python libraries. We also introduce basics of time series analysis. The topics are: A Brief matplotlib API Primer, Plotting with pandas and seaborn. Date and Time Data Types and Tools, Time Series Basics, Date Ranges, Frequencies, and Shifting, Time Zone Handling, Periods and Period Arithmetic.	
	The topics are to be discussed based on chapters 9 and 11 of Text1.		
	Note: Some data analysis examples are given in Chapter 14 of the Text1 which can be used for practise. The data mentioned in chapter 14 can be downloaded from https://github.com/wesm/pydata-book.		

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the python modules numpy, pandas, and matplotlib, and acquire ability to use various functions in these modules to solve problems.	U, Ap, C	PSO- 1,3,6
CO-2	Understand and use some data handling techniques using python and acquire ability to apply them to solve problems.	U, Ap, C	PSO- 1,3,6
CO-3	Visualize and analyse data using the plotting techniques using python modules and solve problems.	U, Ap, C	PSO- 1,3,6

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Note: 1 or 2 COs/module

Name of the Course: Credits: 3:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
1	Understand the python modules NumPy, pandas, and matplotlib, and acquire ability to use various functions in these modules to solve problems.	PO 1,2/ PSO- 1,3,6	C, P	U, Ap, C	L	
2	Understand and use some data handling techniques using python and acquire ability to apply them to solve problems.	PO 1,2,3,5/ PSO- 1,3,6	C, P	U, Ap, C	L	
3	Visualize and analyse data using the plotting techniques using python modules and solve problems.	PO 1,2,5,6/ PSO- 1,3,6	C, P	U, Ap, C	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	2	3	2	2	3	-	-	3	3	2	2	2	1	1
CO 2	3	-	3	1	1	3	-	1	3	3	3	-	3	2	-
CO 3	3	2	3	-	1	3	2	-	3	3	2	-	3	3	1

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓	✓		✓

SEMESTER – VI

Mar Ivanios College (Autonomous)

Discipline	**MATHEMATICS**				
Course Code	MIUK6DSCMAT350.1				
Course Title	**Real Analysis II**				
Type of Course	DSC				
Semester	VI				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-	-	4
Pre-requisites	1. Basics of set theory, functions 2. Sequences and Series				
Course Summary	This course provides a comprehensive study of limits, exploring various definitions and the algebraic properties of limit functions. It delves into criteria for divergence and discontinuity of functions, as well as the composition of functions and their continuity properties. Continuity concepts are further examined in the context of compact sets and results on uniform continuity. The course introduces key theorems including the intermediate value theorem, Rolle's theorem, and the mean value theorem, highlighting their significance in analyzing functions. Monotone functions and their continuity properties are explored, along with the concept of families of functions and examples. Uniform convergence of function families is discussed, leading into a thorough examination of differentiability, including definitions, algebraic operations, and composition of differentiable functions. The interior				

	extremum theorem, Darboux's theorem, and L'Hospital's rule are also covered. Transitioning to integration theory, the course explores Riemann integration, upper and lower Riemann sums, and criteria for integrability. The fundamental theorem of calculus is introduced, along with its proof, emphasizing the relationship between continuity and the existence of integrals. Algebraic operations on integrable functions are explored, providing a comprehensive understanding of integral calculus.
Text	Stephen Abbott, *Understanding Analysis*, Second Edition, Springer. Chapter 4: Sections 4.1 – 4.5 Chapter 5: Sections 5.1 – 5.4 Chapter 6: Sections 6.1 – 6.3 Chapter 7: Sections 7.1 – 7.5
References	1. Robert G. Bartle, Donald R. Sherbert, *Introduction to Realm Analysis*, Fourth Edition, John Wiley & Sons. 2. Ajit Kumar, S. Kumaresan, *A Basic Course in Real Analysis*, CRC Press. 3. Sterling K. Berberian, A First Course in Real Analysis, Springer.

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Continuity of functions**	**15**
	1	Various versions of definition of limits	3
		The algebra of limits of functions	2
	2	The divergence criterion for functional limits	2
		The discontinuity criterion	2
		Composition of functions and continuity	2
	3	continuity and compact sets	4
II		**Uniform continuity and uniform convergence**	**15**
	1	Results on uniform continuity	3
	2	The intermediate value theorem	2

		Monotone functions and their continuity	2
	3	Family of functions and examples	3
		Uniform convergence of family of functions	5
III		**Differentiability of functions**	**15**
	1	Definition of differentiability of functions	2
		Algebra and composition of differentiable functions	2
	2	The interior extremum theorem	2
		Darboux's theorem	2
		The mean value theorem	1
		Rolle's Theorem	1
	3	L'Hospitals rules	5
IV		**Riemann Integration**	**15**
	1	Theory of Riemann integration	2
		Upper and lower Riemann sums	2
	2	The integrability criterion	3
		Continuity and the existence of integral	2
	3	Algebraic operations on integrable functions	3
		The fundamental theorem of calculus and its proof	3

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO -1	analyse and evaluate the properties of real numbers, including their upper and lower bounds, supremum, infimum, maximum, and minimum, and apply these concepts to solve mathematical problems.	R, U, Ap	PSO: 1, 2, 3, 4, 5, 6, 7
CO -2	demonstrate understanding of the density of rational and irrational numbers, and utilize this knowledge to prove the uncountability of certain sets, such as the interval (0,1), using	R, U, Ap, An	PSO: 1, 2, 3, 4, 5, 6, 7

	Cantor's theorem.		
CO -3	apply the Nested Interval Property to analyse intervals and their properties, including the existence of square roots within the real number system.	E, R, U, Ap	PSO: 1, 2, 3, 4, 5, 6, 7
CO -4	investigate the behaviour of sequences, including limits, divergence, and the existence of sub sequences, and utilize algebraic operations to manipulate and evaluate limits.	E, Ap, An, C	PSO: 1, 2, 3, 4, 5, 6, 7
CO -5	apply key convergence tests, such as the Monotone Convergence Theorem, the Bolzano-Weierstrass Theorem, and Cauchy's condensation test, to determine the convergence of series and sequences.	U, Ap, An	PSO: 1, 2, 3, 4, 5, 6, 7
CO -6	analyse and manipulate sets in $\mathbb{R}$, including open and closed sets, complements, and compactness, and understand the concepts of perfect and connected sets within the real number system.	Ap, An	PSO: 1, 2, 3, 4, 5, 6, 7

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)
1	analyse and evaluate the properties of real numbers, including their upper and lower bounds, supremum, infimum, maximum, and minimum, and apply these concepts to solve mathematical problems.	PO: 1, 2, 4, 5, 6 PSO: 1, 2, 3, 4, 5, 6, 7	R, U, Ap	F, C, P	L
2	demonstrate understanding of the density of rational and irrational numbers, and utilize this knowledge to prove the uncountability of certain sets, such as the interval $(0,1)$, using Cantor's theorem.	PO: 1, 2, 4, 5, 6 / PSO: 1, 2, 3, 4, 5, 6, 7	R, U, Ap, An	C, P, M	L
3	apply the Nested Interval Property to analyse intervals and their properties, including the existence of square roots within the real number system.	PO: 1, 2, 4, 5, 6 / PSO: 1, 2, 3, 4, 5, 6, 7	E, R, U, Ap	P, M	L
4	investigate the behaviour of sequences, including limits, divergence, and the existence of sub sequences, and utilize algebraic operations to manipulate and evaluate limits.	PO: 1, 2, 4, 5, 6 PSO: 1, 2, 3, 4, 5, 6, 7	E, Ap, An, C	F, C, M	L
5	apply key convergence tests, such as the Monotone Convergence Theorem, the Bolzano-Weierstrass Theorem, and Cauchy's condensation test, to determine the convergence	PO: 1, 2, 4, 5, 6 / PSO: 1, 2, 3,	U, Ap, An	F, C P	L

	of series and sequences.	4, 5, 6, 7			
6	analyse and manipulate sets in $\mathbb{R}$, including open and closed sets, complements, and compactness, and understand the concepts of perfect and connected sets within the real number system.	PO: 1, 2, 4, 5, 6 / PSO: 1, 2, 3, 4, 5, 6, 7	Ap, An	F, M	L

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO 4	PS O5	PS O6	PS O 7	PS O 8	PO1	PO2	PO3	PO4	PO5	PO6	PO 7
CO 1	3	3	2	1	1	1	2	-	1	3	-	1	1	1	-
CO 2	3	3	2	1	1	1	2	-	1	3	-	1	1	1	-
CO 3	3	3	2	1	1	1	2	-	1	3	-	1	1	1	-
CO 4	3	3	2	1	1	1	2	-	1	3	-	1	1	1	-
CO 5	3	3	2	1	1	1	2	-	1	3	-	1	1	1	-
CO 6	3	3	2	1	1	1	2	-	1	3	-	1	1	1	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓			✓
CO 4		✓		✓
CO 5		✓		✓
CO 6			✓	

Mar Ivanios College (Autonomous)

Discipline	**MATHEMATICS**				
Course Code	MIUK6DSCMAT351.1				
Course Title	**Operations Research**				
Type of Course	DSC				
Semester	VI				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	1. Linear Equations 2. Inequalities				
Course Summary	This course at the undergraduate level typically covers mathematical modelling, optimization techniques, and decision-making methods to solve complex problems in operations and decision sciences. It covers formulation of LPP, various methods to solve LPP, methods of transportation, assignment problems and project management techniques like CPM and PERT. This course equips students with quantitative problem-solving skills and analytical tools necessary for optimizing processes, making informed decisions, and improving efficiency in various organizational settings and preparing students for careers in operations research, management consulting, and related fields.				
Prescribed Text	J K Sharma: Operations Research - Theory and Applications, 6th Edition, Trinity Publications				
Reference Textbooks	1. Hamdy A Taha: Operations Research: An Introduction (10th Edition) 2. Kanti Swarup, P. K. Gupta, Man Mohan: Operations				

	Research **3.** Ravindran - Philips - Solberg: Operations Research- Principles and Practice

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Linear Programming**	**15**
	1	Formulation of Linear Programming models	5
	2	Graphical solution of Linear Programs in two variables	5
	3	Linear Programs in standard form - basic variable - basic solution- basic feasible solution-feasible solution	5
		[The topics to be discussed in this module can be found in Chapter 1,2,3 of the prescribed text]	
II		**Simplex method**	**15**
	4	Solution of a Linear Programming problem using simplex method (Since Big- M method is not included in the syllabus, avoid questions in simplex method with constraints of $\geq$ or = type).	10
	5	Formulation of Dual LPP , Symmetrical Form, Economic Interpretation of Dual Variables , Rules for Constructing the Dual from Primal.	5
		[The topics to be discussed in this module can be found in Chapter 4, 5 of the prescribed text]	
III		**Transportation Problems**	**15**
	6	Linear programming formulation - Initial basic feasible solution (Vogel's approximation method/ North-west corner rule)	6
	7	– degeneracy in basic feasible solution - Modified distribution method – optimality test.	4
		Standard assignment problems - Hungarian method for solving an assignment problem.	5
		[The topics to be discussed in this module can be found in Chapter 9,10 of the prescribed text]	
IV		**Project Management**	**15**

	8	Activity -dummy activity - event - project network, CPM (solution by network analysis only),	9
	9	PERT.	6
		[The topics to be discussed in this module can be found in Chapter 13 of the prescribed text]	
		Use CAS wherever possible	

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Formulate LPP and Solve LPP using Graphical method	Ap, An, E, C	1,2,3
CO-2	Determine the solution of LPP using Simplex method	Ap, An, E	1,2,3,4
CO-3	Use Vogel's Approximation method and North West corner method to solve the transportation problem and Hungarian method to solve assignment problems	An, Ap,E	1,2,3,4,5
CO-4	Apply the techniques of CPM and PERT to solve the real-life problems	Ap, An, E, C	1,2,3,4,5,8

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
1	Formulate LPP and Solve LPP using Graphical method	PO 1,2/PSO 1,2,3	Ap, An, E, C	F, C	L	
2	Determine the solution of LPP using Simplex method	PO 1,2/PSO 1,2,3,4	Ap, An, E	C	L	
3	Use Vogel's Approximation method and North West corner method to solve the transportation problem and Hungarian method to solve assignment problems	PO 1,2,4,6/PSO 1,2,3,4,5	An, Ap,E	C,M	L	
4	Apply the techniques of CPM and PERT to solve the real-life problems	PO 1,2,4,6,7/ PSO 1,2,3,4,5,8	Ap, An, E, C	F, C ,M	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	3	3	-	-	-	2	2	3	3	-	-	-	-	-
CO 2	3	3	3	3	-	-	-	-	3	3	2	3	1	3	-
CO 3	3	3	3	3	3	2	-	1	3	3	-	3	2	3	1
CO 4	3	3	3	3	3	2	1	3	3	3	-	3	2	3	1

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3		✓		✓
CO 4		✓		✓

Mar Ivanios College (Autonomous)

Discipline	**MATHEMATICS**				
Course Code	MIUK6DSCMAT352.1				
Course Title	**Abstract Algebra – Ring Theory**				
Type of Course	**DSC**				
Semester	VI				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-	-	4
Pre-requisites	1. Basics of Group Theory 2. Properties of integers, rational numbers, and real numbers, especially multiplication. 3. Modular Arithmetic				
Text Book	**Text:** Joseph Gallian, ***Contemporary Abstract Algebra***, 9th Edition, Cengage Learning References: 1. D S Dummit, R M Foote, *Abstract Algebra*, 3rd Edition, Wiley 2. I N Herstein, *Topics in Algebra*, Vikas Publications				
Course Summary	This course aims to give a basic and concrete idea of Ring Theory. The topics are discussed with enough motivation through examples. We begin with a discussion on group homomorphisms and classification of finite abelian groups. Then we introduce rings, integral domains, and fields. The ideal, factor rings, and related topics are discussed in detail. The ring homomorphisms and factor rings are also discussed in the course. We give a detailed description of factorization of polynomials				

	over fields and use the results to theoretically construct a finite field of given order.

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Homomorphisms and Isomorphisms**	**15**
	1	Definition, examples, and properties of group homomorphisms	7
	2	The first isomorphism theorem	4
	3	Fundamental Theorem of finite abelian groups	1
	4	Classification of finite abelian groups up to isomorphism	3
	The topics to be discussed are from chapters 10 and 11 of the Text		
II		**Introduction to Rings**	**15**
	5	Motivation, definition, examples, and properties of rings	5
	6	Subrings	2
	7	Integral Domains and Fields	5
	8	Characteristic of a ring	3
	The topics to be discussed are from chapters 12 and 13 of the Text		
III		**Ideals, Factor Rings, and Ring Homomorphisms**	**15**
	9	Ideals, Factor rings	5
	10	Prime and Maximal ideals	3
	11	Definition, examples, and properties of ring homomorphisms	5
	12	Field of quotients of an Integral domain	2
	The topics to be discussed are from chapters 14 and 15 of the Text		
IV		**Polynomials in Rings and their factorization**	**15**
	13	Polynomials - introduction and related terminology	5
	14	Division Algorithm of polynomials	2

	15	Consequences of division algorithm	2
	16	Reducibility and irreducibility tests, construction of finite fields	5
	17	Unique factorization of polynomials over integers	1
	The topics to be discussed are from chapters 16 and 17 of the Text		

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the idea of group homomorphism and acquire ability to determine homomorphisms between finite cyclic groups.	U, R, Ap, E	PSO-1,2
CO-2	Acquire the ability to classify groups based on the fundamental theorem of Isomorphism for Finitely Generated Abelian Groups	U, Ap	PSO-1,2
CO-3	Get a strong foundation various structures ring, integral domain, and field. Acquire ability to apply the results to solve problems.	U, R, Ap, E	PSO-1,2,3
CO-4	Understanding the notion of ideals, factor rings and acquire ability to solve the related problems.	U, R, Ap, E	PSO-1,2,3
CO-5	Understand the factorization and irreducibility of polynomials over rings and fields. Acquire ability to identify irreducible polynomials and theoretically construct finite fields of given order.	U, R, Ap, E	PSO-1,2,3,4

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
1	Understand the idea of group homomorphism and acquire ability to determine homomorphisms between finite cyclic groups.	PO 1,2/PSO-1,2	U, R, Ap, E	F, C	L	
2	Acquire the ability to classify groups based on the fundamental theorem of Isomorphism for Finitely Generated Abelian Groups	PO 1,2/PSO-1,2	U, Ap	F, C	L	
3	Get a strong foundation various structures ring, integral domain, and field. Acquire ability to apply the results to solve problems.	PO 1,2/PSO-1,2,3	U, R, Ap, E	F, C	L	
4	Understanding the notion of ideals, factor rings	PO 1,2,6/PSO-	U, R,	F, C,		

	and acquire ability to solve the related problems.	1,2,3	Ap, E	M		
5	Understand the factorization and irreducibility of polynomials over rings and fields. Acquire ability to identify irreducible polynomials and theoretically construct finite fields of given order.	PO 1,2,6/PSO-1,2,3,4	U, R, Ap, E	F, C,M	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO 4	PS O5	PS O6	PSO 7	PSO 8	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	3	2	1	-	1	-	1	3	3	2	2	-	-	1
CO 2	3	3	2	1	1	-	2	2	3	3	1	1	1	2	-
CO 3	3	3	3	-	1	1	2	-	3	3	1	-	1	-	1
CO4	3	3	3	2	-	2	-	1	3	3	2	1	-	3	-
CO5	3	3	2	2	1	3	2	-	3	3	2	1	1	3	1

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓			✓
CO 4		✓		✓
CO 5		✓		✓

Mar Ivanios College (Autonomous)

<table>
<tr><td>Discipline</td><td colspan="5">MATHEMATICS</td></tr>
<tr><td>Course Code</td><td colspan="5">MIUK6DSEMAT353.1</td></tr>
<tr><td>Course Title</td><td colspan="5">Differential Equations</td></tr>
<tr><td>Type of Course</td><td colspan="5">DSE</td></tr>
<tr><td>Semester</td><td colspan="5">VI</td></tr>
<tr><td>Academic Level</td><td colspan="5">300 - 399</td></tr>
<tr><td rowspan="2">Course Details</td><td>Credit</td><td>Lecture per week</td><td>Tutorial per week</td><td>Practical per week</td><td>Total Hours/Week</td></tr>
<tr><td>4</td><td>4 hours</td><td>-</td><td>-</td><td>4</td></tr>
<tr><td>Pre-requisites</td><td colspan="5">Differentiation, Polynomials, Integration.</td></tr>
<tr><td>Text Book</td><td colspan="5">Text:
Text.1 Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edition, Wiley-India.
Text.2 B.S. Grewal, Higher Engineering Mathematics, 42nd Edition, Khanna Publishers.
References:
1. K. F. Riley, M. P. Hobson, S. J. Bence, Mathematical Methods for Physics and Engineering, 3rd Edition, Cambridge University Press.
2. H. Anton, I. Bivens, S. Davis, Calculus, 10th Edition, John Wiley &Sons.
3. George. B. Afken, Hans. J. Weber, Frank. E. Harris, Mathematical Methods for Physicists, 7th Edition, Academic Press.
4. Mary L. Boas, Mathematical Methods in the Physical Sciences, Third Edition, John Wiley &Sons.</td></tr>
<tr><td colspan="6"></td></tr>
<tr><td>Course Summary</td><td colspan="5">The course covers a comprehensive range of topics in Differential equations (first order and second order differential equation). It begins</td></tr>
</table>

	with the study of first order differential equation. Separable differential equation, Exact differential equation, Bernoulli's differential equation, Homogeneous differential equation are introduced here. Differential equations of first order and higher degree are studied. Linear differential equation with constant coefficient are studied. We discuss second order equations and various methods to solve them. Sufficient of exercises also should be done for understanding the concept thoroughly. The main topics in this module are the following. Homogeneous linear differential equation of second order, Basis and general solutions, finding a basis when one solution is known, Euler – Cauchy equations, existence and uniqueness of solutions with respect to Wronskian, Method of Undetermined coefficients, solution by Variation of parameters, Modeling of Mass – spring system, Forced oscillation and Resonance.

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**First Order Ordinary Differential Equation**	**20**
	1	Basic concept of a differential equation, its solution, initial value problems, separable ODE, reduction to separable form, exact ODEs and integrating factors. Reducing to exact form.	5
		Homogeneous and non- homogeneous linear ODEs, special equations like Bernoulli's equation. Equations of the First Order and Higher Degree, Clairaut's Equation. Understanding the existence uniqueness of solutions theorem.	15
		[The topics in this module can be found in Chapter 1 of Text.1]	
II		**Linear Differential Equations with constant coefficients**	**10**
	2	Definitions, Operator D, Rules for finding Complementary function, Rules for finding the Particular integrals. Working procedure to solve the equation, Linear Dependence of solutions.	
		[The topics in this module can be found in Chapter 13: section 13.1 to 13.6 of Text.2]	
III		**Second Order Ordinary Differential Equation**	**20**
		Homogeneous linear differential equation of second order, initial value problem, Basis and general solutions, finding a basis when	

III	3 3	one solution is known, Euler – Cauchy equations, existence and uniqueness of solutions with respect to Wronskian, solving non- homogeneous ODE via the Method of Undetermined coefficients, solution by Variation of parameters.	5 15
	[The topics in this module can be found in Chapter 2 of Text. 1]		
IV	**Application of Ordinary Differential Equation**		**10**
	4	Modelling of Mass – spring system, Forced oscillation and Resonance.	
	[The topics in this module can be found in Chapter 2 of Text. 1]		

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Gain an idea of Differential equation. Understanding different types of first order differential equation. Ability to solve first order differential equation.	Ap, R, C	PSO-1,3
CO-2	Master to solve first order differential equation. Recognise different first order differential equation and identify the method to solve them. Understanding the existence uniqueness of solutions theorem.	An, E, U	PSO-1,7
CO-3	Gain the idea of second order differential equation, finding a basis when one solution is known, Understanding. Euler-Cauchy equation, understanding existence and uniqueness of solutions	An, R, U	PSO-1,5
CO-4	Recognise second order ordinary differential equation, Understanding different methods to solve second order ordinary differential	C, R, E	PSO-2,8
CO-5	Application of differential equation. Gain proficiency in application.	Ap, U, C	PSO-1,4

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/ PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)
CO-1	Gain an idea of Differential equation. Understanding different types of first order differential equation. Ability to solve first order differential equation.	PSO-1,3	Ap, R, C	F, C	L
CO-2	Master to solve first order differential equation. Recognise different first order differential equation and identify the method to solve them. Understanding the existence uniqueness of solutions theorem.	PSO-1,7	An, E, U	P	L
CO-3	Gain the idea of second order differential equation, finding a basis when one solution is known, Understanding. Euler-Cauchy equation, understanding existence and uniqueness of solutions	PSO-1,5	An, R, U	C	L
CO-4	Recognise second order ordinary differential equation, Understanding different methods to solve second order ordinary differential	PSO-2,8	C, R, E	U	L
CO-5	Application of differential equation. Gain proficiency in application.	PSO-1,4	Ap, U, C	F, C	L

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	1	2	3	3	3	2	1	2	2	3	3	3	2	3
CO 2	3	2	2	3	2	2	3	3	1	3	2	2	2	2	2
CO 3	2	2	1	2	1	1	3	2	3	3	1	1	3	2	1
CO 4	1	3	3	3	2	3	1	1	2	1	2	3	2	1	2
CO 5	2	3	2	1	3	2	2	2	3	2	3	2	2	3	2

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓			✓
CO 4		✓		✓
CO 5		✓		✓

Mar Ivanios College (Autonomous)

Discipline	**MATHEMATICS**				
Course Code	MIUK6DSEMAT354.1				
Course Title	**Integral Transforms**				
Type of Course	**DSE**				
Semester	VI				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-	-	4
Pre-requisites	1. Differentiation 2. Integration				
Course Summary	Integral Transforms is a mathematical course that delves into the study of transforming functions from one domain to another through integral operators. The course explores various integral transforms, their properties, and their applications in solving differential equations and analyzing signals and systems. It covers fundamental concepts, problem-solving techniques, and practical applications in mathematics, engineering, physics, and other fields.				
Text Book	Erwin Kreyszig, *Advanced Engineering Mathematics*, 10th Edition, Wiley-India				
Reference Textbooks	1. Peter V. O' Neil, Advanced Engineering Mathematics, Thompson Publications, 2007 2. M Greenberg, Advanced Engineering Mathematics, 2nd Edition, Prentice Hall. 3. B.S Grewal, Higher Engineering Mathematics, Khanna Publishers				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Laplace Transforms - Introduction**	**15**
	1	Laplace Transform-Linearity. First Shifting Theorem (s-Shifting), Transforms of Derivatives and Integrals-ODEs, Unit Step Function (Heaviside Function)-Second Shifting Theorem (t-Shifting)	
	The topics to be discussed are from Chapter 6, Sections 1-3 of Text		
II		**Laplace Transforms - Applications**	**15**
	2	Motivation, definition, examples, and properties of ringsShort Impulses-Dirac's Delta Function-Partial Fractions, Convolution-Integral Equations, Differentiation and Integration of Transforms-ODEs with Variable Coefficients, Systems of ODEs	
	The topics to be discussed are from Chapter 6, Sections 3-7 of Text		
III		**Fourier Series**	**15**
	3	Fourier Series, Basic Examples, Derivation of the Euler Formulas, Convergence and Sum of a Fourier Series, Arbitrary Period-Even and Odd Functions-Half-Range Expansions from Period 2 to any Period P = 2L, Simplifications: Even and Odd Functions, Half-Range Expansions	
	The topics to be discussed are from Chapter 11, Sections 1-2 of Text		
IV		**Fourier Transforms**	**15**
	4	Fourier Integral, From Fourier Series to Fourier Integral, Applications of Fourier Integrals, Fourier Cosine Integral and Fourier Sine Integral, Fourier Cosine and Sine Transforms, Linearity, Transforms of Derivatives, Fourier Transform, Complex Form of the Fourier Integral, Fourier Transform and Its Inverse, Linearity. Fourier Transform of Derivatives, Convolution.	
	The topics to be discussed are from Chapter 11, Sections 7-9 of Text		

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed

CO-1	Identify and describe common integral transforms such as the Laplace transform and apply first shifting theorem to solve problems related to it	U, Ap,E	PSO-1,2,3
CO-2	Apply integral transform techniques to solve ordinary differential equations arising in engineering, physics, and other fields and Use integral transforms to analyze and solve boundary value problems and initial value problems,	Ap, An,E	PSO-1,2,3,5,6,8
CO-3	Derive solutions of Fourier Series by applying the Euler's Formula	Ap	PSO-1,2,3,4
CO-4	Apply integral transform techniques to real-world problems in engineering, physics, and other disciplines, interpret and explain the physical significance of transformed functions and their implications for practical applications.	Ap, An, E,	PSO-1,2,3

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
1	Identify and describe common integral transforms such as the Laplace transform and apply first shifting theorem to solve problems related to it	PO 1,2 /PSO-1,2,3	U, Ap,E	F, C	L	
2	Apply integral transform techniques to solve ordinary differential equations arising in engineering, physics, and other fields and Use integral transforms to analyze and solve boundary value problems and initial value problems,	PO 1,2,6/PSO-1,2,3,5,6,8	Ap, An,E	C,M	L	
3	Derive solutions of Fourier Series by applying the Euler's Formula	PO 1,2,6/ PSO-1,2,3,4	Ap	C, P	L	
4	Apply integral transform techniques to real-world problems in engineering, physics, and other disciplines, interpret and explain the physical significance of transformed functions and their implications for practical applications.	PO 1,2 5,6,7/ PSO-1,2,3	Ap, An, E,	F,C,M	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	3	3	3	-	-	-	-	-	3	3	2	-	-	1	1
CO 2	3	3	3	2	3	3	1	3	3	3	-	-	1	3	2
CO 3	3	3	3	3	2	-	-	1	3	3	-	1	2	3	1
CO 4	3	3	3	2	-	-	1	-	3	3	2	-	3	3	3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓	✓		✓
CO 3		✓		✓
CO 4		✓		✓

Mar Ivanios College (Autonomous)

Discipline	**MATHEMATICS**				
Course Code	MIUK6SECMAT355.1				
Course Title	**Introduction to Machine Learning**				
Type of Course	**SEC**				
Semester	VI				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	3		-	-	3
Pre-requisites	Basic calculus Linear algebra (matrix operations, eigenvalues, eigenvectors) Probability and statistics (probability distributions, expected value, variance)				
Text Books	1. Alpaydin E, *Introduction to machine learning*, MIT press, 2009. 2. Jiawei Han, Micheline Kamber, and Jian Pei, *Data Mining Concepts and Techniques*, Third Edition, Morgan Kaufmann, Elsevier. 3. Simon Haykin, *Neural Networks*, Pearson. 4. Andreas C. Muller and Sarah Guido, *Introduction to machine learning with Python*:				
Course Summary	This course introduces undergraduate mathematics students to the fundamentals of machine learning, focusing on mathematical principles, algorithms, and applications. Students will learn various techniques for supervised and unsupervised learning, including regression, classification, clustering, dimensionality reduction, and optimization. Practical using Python has to be done.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Supervised Learning**	
		Overview of machine learning, Types of machine learning (supervised, unsupervised, reinforcement learning), Linear regression, over fitting/under fitting, bias/variance, model evaluation techniques, k-nearest neighbour, Logistic regression, naive bias classifier, Decision Trees and Random Forests	15
II		**Unsupervised Learning**	
		K-means clustering, Hierarchical clustering, Principal Component Analysis (PCA), association rules, apriori algorithm, Ensemble learning, bagging/boosting, adaboost, outlier mining, class imbalance, multi class classification	15
III		**Neural Networks**	
		Fundamentals of artificial neural networks, operations in a neuron, activation functions, universal approximation theorem, single layer perceptron, back propagation algorithm, multilayer feedforward networks, associative memories.	15

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the basics of machine learning.	R,U	PSO 2,3,4,6,7
CO-2	Understand supervised learning and apply the knowledge to do related problems.	R,U, Ap	PSO 2,3,4,6,7
CO-3	Understand unsupervised learning and apply the knowledge to do related problems.	R,U, Ap	PSO 2,3,4,6,7
CO-4	Understand the basics of Neural network	R,U	PSO 2,3,4,6,7

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Note: 1 or 2 COs/module

Name of the Course: Credits: 3:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
1	Understand the basics of machine learning.	PO 1,2/ PSO 2,3,4,6,7	R,U	C, M	L	
2	Understand supervised learning and apply the knowledge to do related problems.	PO 1,2/ PSO 2,3,4,6,7	R,U, Ap	M	L	
3	Understand unsupervised learning and apply the knowledge to do related problems.	PO 1,2,5,6/ PSO 2,3,4,6,7	R,U, Ap	M	L	
4	Understand the basics of Neural network	PO 4,5,6,7/ PSO 2,3,4,6,7	R,U	M	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO 4	PS O5	PS O6	PSO 7	PSO 8	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	2	3	3	3	1	3	3	1	3	3	2	2	1	1	-
CO 2	2	3	3	3	-	3	3	1	3	3	1	1	2	-	1

CO 3	2	3	3	3	1	3	3	-	3	3	2	-	3	3	1
CO4	2	3	3	3	-	3	3	1	2	2	1	3	3	3	3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3		✓		✓
CO 4		✓		✓

SEMESTER – VII

Mar Ivanios College (Autonomous)

<table>
<tr><td>Discipline</td><td colspan="5">MATHEMATICS</td></tr>
<tr><td>Course Code</td><td colspan="5">MIUK7DSCMAT400.1</td></tr>
<tr><td>Course Title</td><td colspan="5">Advanced Linear Algebra</td></tr>
<tr><td>Type of Course</td><td colspan="5">DSC</td></tr>
<tr><td>Semester</td><td colspan="5">VII</td></tr>
<tr><td>Academic Level</td><td colspan="5">400-499</td></tr>
<tr><td rowspan="2">Course Details</td><td>Credit</td><td>Lecture per week</td><td>Tutorial per week</td><td>Practical per week</td><td>Total Hours/Week</td></tr>
<tr><td>4</td><td>4 hours</td><td>-</td><td>-</td><td>4</td></tr>
<tr><td>Pre-requisites</td><td colspan="5">• Vector spaces
• Subspaces
• Bases and dimension</td></tr>
<tr><td></td><td colspan="5">Text:
M. Thamban Nair and Arindama Singh, Linear Algebra, Springer, 2018.

References
1. David Poole, Linear Algebra: A Modern Introduction (IV ed.), Cengage Learning,2015.
2. Gilbert Strang, Linear Algebra and its Applications (IV ed.), Cengage Learning (RS),2005.
3. Kenneth Hoffman, Ray Kunze, Linear Algebra (II ed.), Prentice Hall India Learning Private Limited, 1978.
4. Peter Petersen, Linear Algebra, Springer, 2012.
5. Sheldon Axler, Linear Algebra Done Right (III ed.), Springer Nature, 2015.</td></tr>
</table>

	6. S. Kumaresan, *Linear Algebra: A Geometric Approach*, Prentice Hall India Learning PrivateLimited, 2000.
Course Summary	This course provides a comprehensive idea about the mathematical concepts of linear algebra in an advanced level.

Module	Unit	Content	Hrs
		Vector spaces	
I	I	Vector space, subspaces, linear span, linear independence, Basis and dimension, Basis of any vector space, Sums of subspaces, Quotient space.	15
	The topics to be discussed in this module can be found in Sections 1.1 to 1.9 *of* **the text.**		
		Linear transformations	
II	II	Linearity, Rank and nullity, Isomorphisms, Matrix Representation, change of basis, Space of linear transformations.	15
	The topics to be discussed in this module can be found in Sections 2.1 to 2.7 *of* **the text.**		
		Elementary Operations	
III	III	Elementary row operations, Row echelon form, Row reduced echelon form, Reduction to rank echelon form, Determinant, linear equations, Gaussian and Gaussian Jordan elimination.	15
	The topics to be discussed in this module can be found in Sections 3.1 to 3.8 *of* **the text.**		
		Eigenvalues and Eigenvectors and Block diagonal	

		representation	
IV	IV	Existence of eigenvalues, Characteristic polynomial, Eigenspace, Generalized eigenvectors, Two annihilating polynomials. Diagonalizability, Triangularizability and Block-diagonalization, Schur Triangularizations, Jordan block, Jordan Normal form.	15
	The topics to be discussed in this module can be found in Sections 5.1 to 5.6 and Sections 6.1 to 6.6of **the text .**		

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Write the basis of a vector space, compute its dimension, set up sums of subspaces etc.	R, U, Ap, E	PSO-1,2,3, 4, 7, 8
CO-2	Practice various row reduction techniques of matrices in order to solve systems of linear equations.	R, U, Ap, E	PSO-1,2,3, 4, 7, 8
CO-3	Describe rank and nullity of a linear transformation in connection with solution of linear equations.	R, U, Ap, E	PSO-1,2,3, 4,5, 7, 8
CO-4	Employ different methods to compute eigen values and eigen vectors, which will be very useful for higherstudies and research.	R, U, Ap, E	PSO-1,2, 3, 4, 7, 8
CO-5	Summarize different types of representations of lineartransformations along with their uses.	R, U, Ap, E	PSO-1,2,3,4,5,7, 8
CO-6	Develop critical thinking skills by applying linear algebraic techniques to solve complex problems, formulate conjectures, and analyze the validity of mathematical arguments.	R, U, Ap, E	PSO-1,2, 3, 4, 7, 8

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Note: 1 or 2 COs/module

Advanced Linear Algebra: Credits: 4:0:0 (Lecture: Tutorial: Practical)

CO No.	CO	PO/ PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO1	Write the basis of a vector space, compute its dimension, set up sums of subspaces etc.	PO-1,2, 4,5, 6, 7	R, U, Ap, E	F, C	L	
CO 2	Practice various row reduction techniques of matrices in order to solve systems of linear equations.	PO-1,2, 4,5, 6, 7	R, U, Ap, E	F,P, M	L	
CO3	Describe rank and nullity of a linear transformation in connection with solution of linear equations.	PO-1,2, 4,5, 6, 7	R, U, Ap, E	F, C, P	L	
CO 4	Employ different methods to compute eigen values and eigen vectors, which will be very useful for higherstudies and research	PO-1,2, 4,5, 6, 7	R, U, Ap, C	F, P, M	L	
CO 5	Summarize different types of representations of linear transformations along with their uses.	PO-1,2, 4,5, 6, 7	R, U, An, C	P, M	L	
CO 6	Develop critical thinking skills by applying linear algebraic techniques to solve complex problems, formulate conjectures, and analyze the validity of mathematical arguments.	PO-1,2, 4,5, 6, 7	R, U, An, C	F, P, M	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7
CO 1	3	2	3	2	-	-	2	1	3	3	-	1	3	3	1
CO 2	3	2	3	2	-	-	2	1	3	3	-	1	3	3	1
CO 3	3	2	3	2	2		2	1	3	3	-	1	3	3	1
CO 4	3	2	3	2	-	-	2	1	3	3	-	1	3	3	1
CO 5	3	2	3	2	2		2	1	3	3	-	1	3	3	1
CO 6	3	2	3	2	-	-	2	1	3	3	-	1	3	3	1

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓
CO 6	✓	✓		✓

Mar Ivanios College (Autonomous)

<table>
<tr><td>Discipline</td><td colspan="5">MATHEMATICS</td></tr>
<tr><td>Course Code</td><td colspan="5">MIUK7DSCMAT401.1</td></tr>
<tr><td>Course Title</td><td colspan="5">Advanced Real Analysis</td></tr>
<tr><td>Type of Course</td><td colspan="5">DSC</td></tr>
<tr><td>Semester</td><td colspan="5">VII</td></tr>
<tr><td>Academic Level</td><td colspan="5">400-499</td></tr>
<tr><td rowspan="2">Course Details</td><td>Credit</td><td>Lecture per week</td><td>Tutorial per week</td><td>Practical per week</td><td>Total Hours/Week</td></tr>
<tr><td>4</td><td>4 hours</td><td>-</td><td>-</td><td>4</td></tr>
<tr><td>Pre-requisites</td><td colspan="5">A solid understanding of single-variable calculus.
Familiarity with basic concepts of analysis, such as sets, functions, sequences, and limits,
Understanding of elementary properties of real numbers and their arithmetic operations
problem-solving skills, critical thinking ability, and a willingness to engage deeply with abstract concepts,.</td></tr>
<tr><td></td><td colspan="5">Text:
1. Tom M. Apostol, Mathematical Analysis, Second Edition, Narosa, 1974.
2. Sudhir R. Ghorpade and Balmohan V Limaye, A course in Multivariate Calculus andAnalysis, Springer, 2010.
References
1. J. A. Dieudonne, Foundations of Modern Analysis, Academic Press, 1960.</td></tr>
</table>

	2. W. Rudin, *Real and Complex analysis*, Third Edition, Tata Mc-Graw Hill, 1987. 3. Tom M. Apostol, *Calculus*, Volume-1, Second Edition, Wiley, 1991. 4. Tom M. Apostol, Calculus, Volume-2, Second Edition, Wiley, 1975. 5. N. L. Carothers, *Real Analysis*, Cambridge University Press, 2000.
Course Summary	This course delves into the rigorous and profound principles of advanced calculus and real analysis. It builds upon foundational concepts from calculus and extends them into more abstract and complex realms, providing students with a deeper understanding of mathematical analysis.

Module	Unit	Content	Hrs
		Functions of Bounded Variation and Rectifiable Curves	
I	I	Properties of monotonic functions, Functions of bounded variation, Total variation, Additive property of total variation, Total variation on [a, x] as an increasing function, Function of bounded variation expressed as the difference of increasing functions, Continuous functions of bounded variation, Curves and paths, Rectifiable paths and arc length, Additivity and continuity of arc length, Equivalence of paths, Change of parameter..	15
	The topics to be discussed in this module can be found in Chapter 6 *of* **text 1.**		
		The Riemann - Stieltjles Integral	
II	II	The definition of Riemann - Steiltjles integral, Linear properties, Integration by parts, Change of variable in a Riemann - Stieltjes integral, Reduction to a Riemann integral, Step functions as integrators, Reduction of a Riemann - Stieltjes integral to a finite sum, Euler's summation formula, Monotonically increasing integrators, Upper and lower integrals, Additive and linear properties of upper and lower integrals, Riemann's condition, Comparison Theorems,	15

		Integrators of bounded variation, Sufficient conditions for the existence of Riemann - Stieltjes integrals, Differentiation underthe integral sign.	
	The topics to be discussed in this module can be found in Chapter 7: Sections 7.1 - 7.16 and 7.24 of) *of* **text 1.**		
		Sequence of Functions	
III	III	Point-wise convergence of sequences of functions, Examples of sequences of real-valued functions, Definition of uniform convergence, Uniform convergence and continuity, the Cauchy condition for uniform convergence, Uniform convergence of infinite series of functions, Uniform convergence and Riemann - Stieltjes integration, Non-uniformly convergent series that can be integrated term by term, uniform convergence and differentiation, sufficient conditions for uniform convergence ofa series.	15
	The topics to be discussed in this module can be found in Chapter 9: Sections 9.1- 9.9 (excluding Section 9.7) *of* **text 1.**		
		Multivariate Calculus, Sequences, Continuity and Limits, Partial and Total Differentiation	
IV	IV	Sequences in $\mathbf{R^2}$, Sub- sequences and Cauchy sequences, Compositions of continues functions, Piecing continuous functions on overlapping subsets, Characterizations of continuity, Continuity and boundedness, Continuity and convexity, Continuity and intermediate value property, Uniform continuity, Implicit function Theorem, Limits and continuity. Partial derivative, Directional derivatives, Higher order partial derivatives, Higher order directional derivatives, Differentiability, Taylor's Theorem and Chain rule, Functions of three variables, Extensions	15

		and analogues, Tangent planes normal lines to surfaces.	
	The topics to be discussed in this module can be found in Chapter 2: Sections 2.1, 2.2 (excluding Continuity and monotonicity, Continuity, BoundedVariation, Bounded Bivariation), 2.3 (Excluding Limits from a quadrant, Approaching Infinity) and excluding Section 3.4 and last subsection of Section 3.5) of **text 2.**		

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Classify and explain the notions of limit points, convergent and Cauchy sequences, continuity, connectedness and compactness, monotonic functions and bounded variations and to derive the proofs related to these concepts.	R, U, Ap, E	PSO-1,2,3, 4, 7, 8
CO-2	Summarize how completeness, continuity and other notions are generalized from the real line to metric spaces.	R, U, Ap, E	PSO-1,2,3, 4, 7, 8
CO-3	Employ the Riemann - Stieltjes integrability condition of abounde dfunction and prove a selected number of theorems and concerning integration.	R, U, Ap, E	PSO-1,2,3, 4,5, 7, 8
CO-4	Recognize the differences between point wise and uniformconvergence of a sequence of functions.	R, U, Ap, E	PSO-1,2, 3, 4, 7, 8
CO-5	Calculate the limits of two variable functions, and get the idea that, theexistence of partial derivatives will not implythe differentiability of the function as in single variable case.	R, U, Ap, E	PSO-1,2,3,4,5,7, 8
CO-6	Enhance critical thinking skills by solving challenging mathematical problems and exercises, which require logical reasoning and creative problem-solving techniques.	R, U, Ap, E	PSO-1,2, 3, 4, 7, 8

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Note: 1 or 2 COs/module

Real Analysis: Credits: 4:0:0 (Lecture: Tutorial: Practical)

CO No.	CO	PO/ PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO1	Classify and explain the notions of limit points, convergent and Cauchy sequences, continuity, connectedness and compactness, monotonic functions and bounded variations and to derive the proofs related to these concepts.	PO-1,2, 4,5, 6, 7	R, U, Ap, E	F, C	L	
CO 2	Summarize how completeness, ontinuity and other notions are generalizedfrom the real line to metric spaces..	PO-1,2, 4,5, 6, 7	R, U, Ap, E	F,P, M	L	
CO3	Employ the Riemann - Stieltjes integrability condition of a bounded function and prove a selected number of theorems and concerning integration.	PO-1,2, 4,5, 6, 7	R, U, Ap, E	F, C, P	L	
CO 4	Recognize the differences between point wise and uniform convergence of a sequence of functions.	PO-1,2, 4,5, 6, 7	R, U, Ap, C	F, P, M	L	
CO 5	Calculate the limits of two variable functions, and get the idea that, the existence of partial derivatives will not imply the differentiability of the function as in single variable case.	PO-1,2, 4,5, 6, 7	R, U, An, C	P, M	L	
CO 6	Enhance critical thinking skills by solving challenging mathematical problems and exercises, which require logical reasoning and creative problem-solving techniques.	PO-1,2, 4,5, 6, 7	R, U, An, C	F, P, M	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	2	3	2	-	-	2	1	3	3	-	1	3	3	1
CO 2	3	2	3	2	-	-	2	1	3	3	-	1	3	3	1
CO 3	3	2	3	2	2		2	1	3	3	-	1	3	3	1
CO 4	3	2	3	2	-	-	2	1	3	3	-	1	3	3	1

CO 5	3	2	3	2	2		2	1	3	3	-	1	3	3	1
CO 6	3	2	3	2	-	-	2	1	3	3	-	1	3	3	1

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓
CO 6	✓	✓		✓

Mar Ivanios College (Autonomous)

<table>
<tr><td>Discipline</td><td colspan="5">MATHEMATICS</td></tr>
<tr><td>Course Code</td><td colspan="5">MIUK7DSCMAT402.1</td></tr>
<tr><td>Course Title</td><td colspan="5">Topology</td></tr>
<tr><td>Type of Course</td><td colspan="5">DSC</td></tr>
<tr><td>Semester</td><td colspan="5">VII</td></tr>
<tr><td>Academic Level</td><td colspan="5">400-499</td></tr>
<tr><td rowspan="2">Course Details</td><td>Credit</td><td>Lecture per week</td><td>Tutorial per week</td><td>Practical per week</td><td>Total Hours/Week</td></tr>
<tr><td>4</td><td>4 hours</td><td>-</td><td>-</td><td>4</td></tr>
<tr><td>Pre-requisites</td><td colspan="5">• Basic knowledge of set theory and real analysis.
• Familiarity with concepts such as limits, continuity, and convergence.
• Comfort with mathematical abstraction and formal reasoning.</td></tr>
<tr><td></td><td colspan="5">Text:
Principles of Topology, Fred H. Croom, Baba Barkha Nath Printers (India), Third Reprint, 2009.
References
1. Gerald Buskes, Arnoud van Rooiji, Topological Spaces from
2. James R. Munkres, Topology, PHI Learning Private Limited, Second Edition, 2009.
3. Stephen Willard, General Topology, Dover Publications, 1970.
4. G. F. Simmons, Topology and Modern Analysis, Mc Graw-Hill Inc, New York, 13th reprint, 2010.</td></tr>
</table>

	5. J. Arthur Seebach, Lynn Arthur Steen, *Counter Examples in Topology*, DoverPublications, 1995. 6. Sheldon W. Davis, *Topology*, Tata Mc Graw-Hill, 2006.
Course Summary	This course provides an introduction to fundamental concepts in topology and analysis, focusing on the study of metric spaces, continuous functions, and topological spaces. Students will develop a solid understanding of the basic structures and properties of these mathematical spaces, as well as their applications in various branches of mathematics and beyond.

Module	Unit	Content	Hrs
		Metric Spaces	
I	I	Definition, Examples, Open Sets, Closed Sets, Interior, Closure and Boundary.	15
	The topics to be discussed in this module can be found in . Sections: 3.1, 3.2 and 3.3 *of* **the text.**		
		Continuous Functions	
II	II	Equivalence of metric spaces, Complete metric spaces, Cantor's IntersectionTheorem. [Sections: 3.4, 3.5 and 3.7 (Exercise may be included 3.7(3)].	15
	The topics to be discussed in this module can be found in Sections: 3.4, 3.5 and 3.7 (Exercise may be included 3.7(3) *of* **the text.**		
		Topological Spaces	
III	III	Definition, Examples, Interior, Closure, Boundary, Base, Sub base, Continuity, Topological Equivalence, Subspaces.	15
	The topics to be discussed in this module can be found in Sections: 4.1, 4.2, 4.3, 4.4 and 4.5 *of* **the text.**		

		Connectedness disconnected and Compact spaces	
IV	IV	Theorems on connectedness, connected subsets of real line, Applications of Connectedness, Path connected spaces. compactness and continuity, properties related to compactness, one point compactification.	15
	The topics to be discussed in this module can be found in Sections: 5.1, 5.2, 5.3, 5.4 and 5.5 and Sections: 6.1, 6.2, 6.3 and 6.4 *of* **the text.**		

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Construct topological spaces from metric spaces and using general properties of neighborhoods, open sets, closed sets, basis and sub basis.	R, U, Ap, E	PSO-1,2,3, 4, 7, 8
CO-2	Apply the properties of open sets, closed sets, interior points, accumulation points and derived sets in deriving the proofs of various theorems.	R, U, Ap, E	PSO-1,2,3, 4, 7, 8
CO-3	Interpret and apply the concepts of countable spacesand separable spaces.	R, U, Ap, E	PSO-1,2,3, 4,5, 7, 8
CO-4	Demonstrate compactification and related theorems..	R, U, Ap, E	PSO-1,2, 3, 4, 7, 8
CO-5	Justify the concepts and properties of the compactand connected topological spaces.	R, U, Ap, E	PSO-1,2,3,4,5,7, 8
CO-6	Apply topological concepts to solve problems in various mathematical contexts.	R, U, Ap, E	PSO-1,2, 3, 4, 7, 8

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Note: 1 or 2 COs/module

Topology: Credits: 4:0:0 (Lecture: Tutorial: Practical)

CO No.	CO	PO/ PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO1	Construct topological spaces from metric spaces and using general properties of neighborhoods, open sets, closed sets, basis and sub basis.	PO-1,2, 4,5, 6, 7	R, U, Ap, E	F, C	L	
CO 2	Apply the properties of open sets, closed sets, interior points, accumulation points and derived sets in deriving the proofs of various theorems.	PO-1,2, 4,5, 6, 7	R, U, Ap, E	F,P, M	L	
CO3	Interpret and apply the concepts of countable spacesand separable spaces.	PO-1,2, 4,5, 6, 7	R, U, Ap, E	F, C, P	L	
CO 4	Demonstrate compactification and related theorems..	PO-1,2, 4,5, 6, 7	R, U, Ap, C	F, P, M	L	
CO 5	Justify the concepts and properties of the compactand connected topological spaces.	PO-1,2, 4,5, 6, 7	R, U, An, C	P, M	L	
CO 6	Apply topological concepts to solve problems in various mathematical contexts.	PO-1,2, 4,5, 6, 7	R, U, An, C	F, P, M	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	2	3	2	-	-	2	1	3	3	-	1	3	3	1
CO 2	3	2	3	2	-	-	2	1	3	3	-	1	3	3	1
CO 3	3	2	3	2	2		2	1	3	3	-	1	3	3	1
CO 4	3	2	3	2	-	-	2	1	3	3	-	1	3	3	1
CO 5	3	2	3	2	2		2	1	3	3	-	1	3	3	1
CO 6	3	2	3	2	-	-	2	1	3	3	-	1	3	3	1

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓
CO 6	✓	✓		✓

Mar Ivanios College (Autonomous)

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<tr><td>Discipline</td><td colspan="5">MATHEMATICS</td></tr>
<tr><td>Course Code</td><td colspan="5">MIUK7DSEMAT403.1</td></tr>
<tr><td>Course Title</td><td colspan="5">Advanced Topics in Graph Theory</td></tr>
<tr><td>Type of Course</td><td colspan="5">DSE</td></tr>
<tr><td>Semester</td><td colspan="5">VII</td></tr>
<tr><td>Academic Level</td><td colspan="5">400-449</td></tr>
<tr><td rowspan="2">Course Details</td><td>Credit</td><td>Lecture per week</td><td>Tutorial per week</td><td>Practical per week</td><td>Total Hours/Week</td></tr>
<tr><td>4</td><td>4 hours</td><td>-</td><td>-</td><td>4</td></tr>
<tr><td>Pre-requisites</td><td colspan="5">Basic of concepts in Graph Theory</td></tr>
<tr><td></td><td colspan="5">Text:

Gary Chartrand and Ping Zhang, Introduction to Graph Theory, Tata Mc Graw Hill, 2006

References
1. J Vasudev C., Graph Theory Applications, New Age India Publication, 2006.
2. West D. B., Introduction to Graph Theory, Pearson Education Inc, 2001.
3. Bondy and Murthy, Graph Theory with Applications, The Macmillan Press Limited,1976.
4. Chartrand G. and L. Lesniak, Graphs and Diagraphs, Prindle, Weber and Schmidt,Boston, 1986.
5. Garey M. R., D. S. Johnson, Computers and Intractability, A Guide to the Theory ofNP-Completeness, Freeman, San</td></tr>
</table>

	Francisco, 1979. 6. Harary F., *Graph Theory*, Addison - Wesley, 1969. 7. K. R. Parthasarathy, *Basic Graph Theory*, Tata Mc Graw-Hill, New Delhi, 1994.
Course Summary	This course is intended to prepare the students for more advanced level leading to research in Graph Theory. By the end of the course students develop a strong foundation in Graph Theory and gain the skills necessary to analyze and solve graph-related problems across different disciplines.

Module	Unit	Content	Hrs
		Solvability	
I	I	Definition of isomorphism, Isomorphism as a relation, Graphs and groups,Reconstruction and solvability.	15
	The topics to be discussed in this module can be found in Sections 3.1, 3.2, 3.3, 3.4 *of* **the text .**		
		Connectivity	
II	II	Cut-vertices, Blocks, Connectivity, Eulerian graphs, Hamilton graphs,Hamilton walksand numbers.	15
	The topics to be discussed in this module can be found in Sections 5.1, 5.2, 5.3, 6.1, 6.2 and 6.3 *of* **the text..**		
		Matchings and Factorization and Graph Coloring	
III	III	Strong diagraphs, Tournaments, matching, Factorization, The Four-color problem, Vertex coloring, Four Color theorem, EdgeColoring, Ramsey number of graphs, Turan's Theorem.	15
	The topics to be discussed in this module can be found in Sections 10.1, 10.2, 10.3, 11.1 and11.2 and Sections 7.1, 7.2, 8.1 and 8.2 *of* **the text .**		
		Distance in Graphs	

IV	IV	The centre of a graph, Distant vertices, locating numbers, Detour anddirected distance. (Sections).	15
	The topics to be discussed in this module can be found in 12.1, 12.2, 12.3, 12.4, 12.5 and 12.6 of **the text.**		

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Describe the basic concepts of graphs, directed graphs andweighted graphs.	R, U, Ap, E	PSO-1,2,3, 4, 7, 8
CO-2	Model Isomorphism of graphs and study Eulerian andHamiltonian graphs.	R, U, Ap, E	PSO-1,2,3, 4, 7, 8
CO-3	Interpret the problems of Matchings and Factorization.	R, U, Ap, E	PSO-1,2,3, 4,5, 7, 8
CO-4	Summarize the vertex and edge coloring of graphs.	R, U, Ap, E	PSO-1,2, 3, 4, 7, 8
CO-5	Apply the knowledge of graphs to solve the real-life problems.	R, U, Ap, E	PSO-1,2,3,4,5,7, 8
CO-6	Develop problem-solving skills by tackling a variety of graph-related problems, and learn to apply critical thinking and creativity in finding solutions.	R, U, Ap, E	PSO-1,2, 3, 4, 7, 8

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Note: 1 or 2 COs/module

Advanced Topics in Graph Theory: Credits: 4:0:0 (Lecture: Tutorial: Practical)

CO No.	CO	PO/ PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO1	Describe the basic concepts of graphs, directed graphs andweighted graphs.	PO-1,2, 4,5, 6, 7	R, U, Ap, E	F, C	L	
CO 2	Model Isomorphism of graphs and study Eulerian andHamiltonian graphs.	PO-1,2, 4,5, 6,	R, U, Ap, E	F,P, M	L	

		7				
CO3	Interpret the problems of Matchings and Factorization.and concerning integration.	PO-1,2, 4,5, 6, 7	R, U, Ap, E	F, C, P	L	
CO 4	Summarize the vertex and edge coloring of graphs.	PO-1,2, 4,5,6,	R, U, Ap, C	F, P, M	L	
CO 5	Apply the knowledge of graphs to solve the real-lifeproblems.	PO-1,2, 4,5,6,7	R, U, An, C	P, M	L	
CO 6	Develop problem-solving skills by tackling a variety of graph-related problems, and learn to apply critical thinking and creativity in finding solutions.	PO-,2, 4,5,6,7	R, U, An, C	F, P, M	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**
CO 1	3	3	3	3	-	-	2	1	3	3	-	1	3	3	1
CO 2	3	3	3	3	-	-	2	1	3	3	-	1	3	3	1
CO 3	3	3	3	3	2		2	1	3	3	-	1	3	3	1
CO 4	3	3	3	3	-	-	2	1	3	3	-	1	3	3	1
CO 5	3	3	3	3	2		2	1	3	3	-	1	3	3	1
CO 6	3	3	3	3	-	-	2	1	3	3	-	1	3	3	1

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓
CO 6	✓	✓		✓

Mar Ivanios College (Autonomous)

<table>
<tr><td>Discipline</td><td colspan="5">MATHEMATICS</td></tr>
<tr><td>Course Code</td><td colspan="5">MIUK7DSEMAT404.1</td></tr>
<tr><td>Course Title</td><td colspan="5">Ordinary Differential Equations</td></tr>
<tr><td>Type of Course</td><td colspan="5">DSE</td></tr>
<tr><td>Semester</td><td colspan="5">VIII</td></tr>
<tr><td>Academic Level</td><td colspan="5">400-499</td></tr>
<tr><td rowspan="2">Course Details</td><td>Credit</td><td>Lecture per week</td><td>Tutorial per week</td><td>Practical per week</td><td>Total Hours/Week</td></tr>
<tr><td>4</td><td>4 hours</td><td>-</td><td>-</td><td>4</td></tr>
<tr><td>Pre-requisites</td><td colspan="5">• Differential Equations</td></tr>
<tr><td></td><td colspan="5">Text:
George F. Simmons, Differential Equations with Applications and Historical Notes,
3rd edition,CRC Press, Taylor and Francis Group, 2016.
References
1. E. A. Coddington & N. Levinson, Theory of Ordinary Differential Equations, Tata-McGraw Hill,2012.
2. W. Walter, Ordinary Differential Equations, Springer, 6th edition, 1996.
3. P. Blanchard, R. L. Devaney & G. R. Hall, Differential Equations, Brooks/Cole, 3rdedition, 2006.
4. G. F. Simmons, Differential Equations with Applications and Historical Notes, McGrawHill, 2ndedition, 1991.</td></tr>
</table>

	5. Dennis G. Zill, *A First Course in Differential Equations with Modeling Applications*,Brooks/Cole, 6th edition, 1997. 6. I. Sneddon, *Elements of Partial Differential Equations*, Dover Publications, Inc., 2006. 7. Erwin Kreyszig, *Advanced Engineering Mathematics*, 9th edition, John Wiley and Sons,2011. 8. D. Greenspan, *Introduction to Partial differential Equations*, TMH Edition, 1961. 9. K. Sankara Rao, *Introduction to Partial Differential Equations*, 3rd edition, PHI Learning,2011.
Course Summary	The course provides students with a solid foundation in the theory and techniques of ordinary differential equations, preparing them to analyze and solve a wide range of differential equations encountered in science, engineering, and other fields.

Module	Unit	Content	Hrs
		Existence and Uniqueness of Solutions	
I	I	The method of successive approximations, Picard's Theorem, systems. The second order linear equation, Oscillations and Sturm Separation theorem, Sturm Comparison theorem.	15
	The topics to be discussed in this module can be found in Chapter 13: Sections 69, 70, 71; Chapter 4: Sections 24, 25 *of* **the text.**		
		Power Series solutions	
II	II	A review of power series, series solutions of first order equations, second order linear equations, ordinary points, regular singular points, two convergence proofs. Gauss's Hypergeometric Equation, The Point at Infinity.	15
	The topics to be discussed in this module can be found in Chapter 5: Sections 26, 27,28, 29, 30, 31, 32 and Appendix A *of* **the text.**		

		Special functions	
III	III	Legendre Polynomials and their properties, Bessel Functions, the Gamma Function, Properties of Bessel Functions, Additional Properties of Bessel Functions.	15
	The topics to be discussed in this module can be found in Chapter 8: Sections 44, 45, 46, 47 and Appendix C *of* **the text.**		
		System of first order equations, Non-linear equations	
IV	IV	General remarks on systems, linear systems, Homogenous linear systems with constant coefficients, non-linear systems. Volterra's Prey-Predator equations. Autonomous systems. The Phase Plane and Its Phenomena, Types of Critical Points. Stability, Critical points and Stability for Linear Systems, Simple critical points of non-linear systems.	15
	The topics to be discussed in this module can be found in Chapter 10:Sections 54, 55, 56, 57and Chapter 16: Sections 58, 59, 60, 62 of **the text .**		

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Apply Picard's Theorem to check the existence ofsolution of differential equations.	R, U, Ap, E	PSO-1,2,3, 4, 7, 8
CO-2	Classify the singular points of second order differentialequations with variable coefficients.	R, U, Ap, E	PSO-1,2,3, 4, 7, 8
CO-3	Write power series solutions of several important classes of ordinary differential equations including Bessel's, Legendre, Gauss's hypergeometric differential equations.	R, U, Ap, E	PSO-1,2,3, 4,5, 7, 8

CO-4	Analyse the stability of linear and non-linear system ofdifferential equations.	R, U, Ap, E	PSO-1,2, 3, 4, 7, 8
CO-5	Summarize the oscillation properties of differential equations..	R, U, Ap, E	PSO-1,2,3,4,5,7, 8
CO-6	Enhance critical thinking skills by analyzing the behavior of differential equation solutions, identifying patterns, and making connections between theoretical concepts and real-world applications.	R, U, Ap, E	PSO-1,2, 3, 4, 7, 8

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Ordinary differential Equations: Credits: 4:0:0 (Lecture: Tutorial: Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)
CO1	Apply Picard's Theorem to check the existence ofsolution of differential equations.	PO-1,2, 4,5, 6, 7	R, U, Ap, E	F, C	L
CO 2	Classify the singular points of second order differentialequations with variable coefficients.	PO-1,2, 4,5, 6, 7	R, U, Ap, E	F,P, M	L
CO3	Write power series solutions of several important classes of ordinary differential equations including Bessel's, Legendre, Gauss's hypergeometric differential equations.	PO-1,2, 4,5, 6, 7	R, U, Ap, E	F, C, P	L
CO 4	Analyse the stability of linear and non-linear system ofdifferential equations.	PO-1,2, 4,5, 6, 7	R, U, Ap, C	F, P, M	L
CO 5	Summarizethe oscillation properties of differential equations..	PO-1,2, 4,5, 6, 7	R, U, An, C	P, M	L
CO 6	Enhance critical thinking skills by analyzing the behavior of differential equation solutions, identifying patterns, and making connections between theoretical concepts and real-world applications.	PO-1,2, 4,5, 6, 7	R, U, An, C	F, P, M	L

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	2	3	2	-	-	2	1	3	3	-	1	3	3	1
CO 2	3	2	3	2	-	-	2	1	3	3	-	1	3	3	1
CO 3	3	2	3	2	2		2	1	3	3	-	1	3	3	1
CO 4	3	2	3	2	-	-	2	1	3	3	-	1	3	3	1
CO 5	3	2	3	2	2		2	1	3	3	-	1	3	3	1
CO 6	3	2	3	2	-	-	2	1	3	3	-	1	3	3	1

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓
CO 6	✓	✓		✓

Mar Ivanios College (Autonomous)

<table>
<tr><td>Discipline</td><td colspan="5">MATHEMATICS</td></tr>
<tr><td>Course Code</td><td colspan="5">MIUK7DSEMAT405.1</td></tr>
<tr><td>Course Title</td><td colspan="5">Abstract Algebra – Field Theory</td></tr>
<tr><td>Type of Course</td><td colspan="5">DSE</td></tr>
<tr><td>Semester</td><td colspan="5">VII</td></tr>
<tr><td>Academic Level</td><td colspan="5">400-499</td></tr>
<tr><td rowspan="2">Course Details</td><td>Credit</td><td>Lecture per week</td><td>Tutorial per week</td><td>Practical per week</td><td>Total Hours/Week</td></tr>
<tr><td>4</td><td>4 hours</td><td>-</td><td>-</td><td>4</td></tr>
<tr><td>Pre-requisites</td><td colspan="5">• Group Theory
• Ring Theory
• Basic idea of Fields</td></tr>
<tr><td></td><td colspan="5">Text:

David S. Dummit and Richard M. Foote, Abstract Algebra, 3rd Edition, Wiley Publications, 2003.

References
1. Joseph A. Gallian, Contemporary Abstract algebra, 8th Edition, Brooks/Cole, Cengage Learning, 2010.
2. John B. Fraleigh, A first course in abstract algebra, 7th edition, Pearson Education Inc, 2003.
3. T. W. Hungerford, Algebra, Springer, 2005.
4. I. N. Heirstein, Topics in Algebra, John Wiley & Sons, 1975.
5. M. Artin, Algebra, Prentice Hall, 1991.</td></tr>
<tr><td>Course Summary</td><td colspan="5">This course is meant basically to help the students to have an advanced mastery of group, ring, and field theories. A solid foundation in the theories of these topics will help the students in the application of these concepts in various branches of Science.</td></tr>
</table>

Module	Unit	Content	Hrs
		Group Actions	
I	I	Group actions and permutation representations, Groups acting on themselves by left multiplication - Cayley's Theorem, Groups acting on themselves by conjugation - The Class Equation, Automorphisms, The Sylow Theorems, The simplicity of A_n.	15
	The topics to be discussed in this module can be found in Sections 4.1 to 4.6 of the Text book		
	Direct and Semi direct products and Abelian groups		
II	II	Direct Products, the fundamental theorem of finitely generated abelian groups, Table of groups of small order, Recognizing direct products, Semidirect products, p-groups, nilpotent groups and solvable groups.	15
	The topics to be discussed in this module can be found in Sections 5.1 to 5.5 and 6.1 of the Text book.		
		Field Theory	
III	III	Basic theory of field extensions, Algebraic extensions, Classical straight edge and compass constructions, Splitting fields and algebraic closures, Separable and inseparable extensions, Cyclotomic polynomials and extensions.	15
	The topics to be discussed in this module can be found in Sections 13.1 to 13.6 of the Text book		
		Galois Theory	
IV	IV	Basic definitions, The fundamental theorem of Galois Theory, Finite fields, Composite extensions and simple extensions, Cyclotomic extensions and abelian extensions over Q, Galois groups of polynomials, Solvable and radical extensions, insolvability of the quintic, Computation of Galois groups over Q, Transcendental extensions, inseparable extensions, infinite Galois groups. (Theorem 14 may be discussed without proof)	15
	The topics to be discussed in this module can be found in Sections 14.1 to 14.9 of the Text book		

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Describe the concept of group actions culminating in Sylow's Theorems and the simplicity of A_n.	R, U, Ap, E	PSO-1,2,3, 4, 7, 8
CO-2	Explain the direct and semi direct product of groups and the fundamental theorem of finitely generated belian groups with the help of which being able to classify groups of small orders.	R, U, Ap, E	PSO-1,2,3, 4, 7, 8
CO-3	Express the basics of field extensions and splitting fields.transformation in connection with solution of linear equations.	R, U, Ap, E	PSO-1,2,3, 4,5, 7, 8
CO-4	Apply the fundamental theorem of Galois Theory with the help of which being able to prove the insolvability of the quintic and to form Galois groups.	R, U, Ap, E	PSO-1,2, 3, 4, 7, 8
CO-5	Summarize the basics of module theory and tensor products of modules and modules over Principal Ideal Domains.	R, U, Ap, E	PSO-1,2,3,4,5,7, 8

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Note: 1 or 2 COs/module

Advanced Linear Algebra: Credits: 4:0:0 (Lecture: Tutorial: Practical)

CO No.	CO	PO/ PSO	Cognitive Level	Knowledge Category	Lecture (L) Tutorial (T)	Practical (P)
CO1	Describe the concept of group actions culminating in Sylow's Theorems and the simplicity of A_n.	PO-1,2, 4,5, 6, 7	R, U, Ap, E	F, C	L	
CO 2	Explain the direct and semi direct product of groups and the fundamental theorem of finitely generated belian groups with the help of which being able to classify groups of small orders.	PO-1,2, 4,5, 6, 7	R, U, Ap, E	F,P, M	L	
CO3	Express the basics of field	PO-	R, U, Ap,	F, C, P	L	

	extensions and splitting fields. transformation in connection with solution of linear equations.	1,2, 4,5, 6, 7	E			
CO 4	Apply the fundamental theorem of Galois Theory with the help of which being able to prove the insolvability of the quintic and to form Galois groups.	PO-1,2, 4,5, 6, 7	R, U, Ap, C	F, P, M	L	
CO 5	Summarize the basics of module theory and tensor products of modules and modules over Principal Ideal Domains.	PO-1,2, 4,5, 6, 7	R, U, An, C	P, M	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**
CO 1	3	2	3	2	-	-	2	1	3	3	-	1	3	3	1
CO 2	3	2	3	2	-	-	2	1	3	3	-	1	3	3	1
CO 3	3	2	3	2	2		2	1	3	3	-	1	3	3	1
CO 4	3	2	3	2	-	-	2	1	3	3	-	1	3	3	1
CO 5	3	2	3	2	2		2	1	3	3	-	1	3	3	1

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓

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<table>
<tr><td>Discipline</td><td colspan="5">MATHEMATICS</td></tr>
<tr><td>Course Code</td><td colspan="5">MIUK7DSEMAT406.1</td></tr>
<tr><td>Course Title</td><td colspan="5">Measure Theory and Integration</td></tr>
<tr><td>Type of Course</td><td colspan="5">DSE</td></tr>
<tr><td>Semester</td><td colspan="5">VII</td></tr>
<tr><td>Academic Level</td><td colspan="5">400-499</td></tr>
<tr><td rowspan="2">Course Details</td><td>Credit</td><td>Lecture per week</td><td>Tutorial per week</td><td>Practical per week</td><td>Total Hours/Week</td></tr>
<tr><td>4</td><td>4 hours</td><td>-</td><td>-</td><td>4</td></tr>
<tr><td>Pre-requisites</td><td colspan="5">• Sequence and series of real numbers and their limits,
• Limit of functions, Continuity and uniform continuity of functions,
• Sequence and series of functions and their limits,
• Riemann Integration.</td></tr>
<tr><td></td><td colspan="5">Text:

G de Barra, Measure Theory and Integration, New Age International Publishers, New Delhi,1981.

References

1 M. Thamban Nair, Measure and Integration, A first course, CRC Publishers, 2019.
2 H. L. Roydon, Real Analysis, Third Edition, Mac – Millan, 1988.
3 W. Rudin, Principles of Mathematical Analysis, 3rd Edition, 1964.
4 P. R. Halmos, Measure Theory, Springer, 1950.
5 E. M. Stein & R. Shakarchi, Real analysis: Measure Theory, Integration, and Hilbert Spaces, Princeton University Press, 2005.
6 G. B. Folland, Real analysis:Modern Techniques and Their Applications, JohnWiley & Sons, 2nd edition, 1999.</td></tr>
</table>

Course Summary	This course delves into foundational concepts essential for understanding modern analysis and probability theory. It explores rigorous mathematical frameworks for measuring sets and functions, paving the way for advanced studies in integration theory, functional analysis, and probability.

Module	Unit	Content	Hrs
		Lebesgue Outer Measure	
I	I	Measurable sets, Regularity, Measurable functions, Borel and Lebesgue Measurability.	15
	The topics to be discussed in this module can be found in Chapter 2: Sections 1 - 5 *of* **the text.**		
		Integration of Non-negative functions	
II	II	The General Integral, Integration of Series, Riemann and Lebesgue Integrals, The Four Derivatives, Lebesgue's Differentiation Theorem, Differentiation and Integration.	15
	The topics to be discussed in this module can be found in Chapter 3: Sections 1 - 4; Chapter 4: Sections 1, 4– statements only and 5 *of* **the text.**		
		Abstract Measure Spaces	
III	III	Measures and Outer Measures, Extension of a measure, Uniqueness of the Extension, Completion of the Measure, Measure spaces, Integration with respect to a Measure. Convex Functions, Jensen's Inequality, The Inequalities of Holder and Minkowski, Completeness of $L^p(\mu)$.	15
	The topics to be discussed in this module can be found in Chapter5: Sections 1 – 6 and Chapter 6: Sections 1 - 5 *of* **the text.**		
		Convergence in Measure	
IV	IV	Signed Measures and the Hahn Decomposition, The	15

		Jordan Decomposition, The Radon Nikodym Theorem, Some Applications of the Radon Nikodym Theorem. ().	
	The topics to be discussed in this module can be found in Chapter 7: Section1 and Chapter 8: Sections 1 - 4) of **the text .**		

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Give Examples how Lebesgue measure on $\mathbb{R}$ is defined.	R, U, Ap, E	PSO-1,2,3, 4, 7, 8
CO-2	Extend how measures may be used to construct integrals.	R, U, Ap, E	PSO-1,2,3, 4, 7, 8
CO-3	Relate the basic convergence theorems for the Lebesgue integral.	R, U, Ap, E	PSO-1,2,3, 4,5, 7, 8
CO-4	Explain the concept of Spaces and its properties	R, U, Ap, E	PSO-1,2, 3, 4, 7, 8
CO-5	Apply the concept of measure to signed measure and interpret a selection of theorems concerning signed measure and Radon Nikodym derivative.	R, U, Ap, E	PSO-1,2,3,4,5,7, 8
CO-6	Apply measure-theoretic techniques to solve problems in analysis, probability theory, and other mathematical disciplines.	R, U, Ap, E	PSO-1,2, 3, 4, 7, 8

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Measure Theory: Credits: 4:0:0 (Lecture: Tutorial: Practical)

CO No.	CO	PO/ PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO1	Give Examples how Lebesgue measure on $\mathbb{R}$ is defined.	PO-1,2, 4,5, 6, 7	R, U, Ap, E	F, C	L	
CO 2	Extend how measures may be used to construct integrals	PO-1,2, 4,5, 6, 7	R, U, Ap, E	F,P, M	L	

CO3	Relate the basic convergence theorems for the Lebesgue integral.	PO-1,2, 4,5, 6, 7	R, U, Ap, E	F, C, P	L	
CO 4	Explain the concept of Spaces and its properties	PO-1,2, 4,5, 6, 7	R, U, Ap, C	F, P, M	L	
CO 5	Apply the concept of measure to signed measure andinterpret a selection of theorems concerning signed measure and Radon Nikodym derivative.	PO-1,2, 4,5, 6, 7	R, U, An, C	P, M	L	
CO 6	Apply measure-theoretic techniques to solve problems in analysis, probability theory, and other mathematical disciplines..	PO-1,2, 4,5, 6, 7	R, U, An, C	F, P, M	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**
CO 1	3	2	3	2	-	-	2	1	3	3	-	1	3	3	1
CO 2	3	2	3	2	-	-	2	1	3	3	-	1	3	3	1
CO 3	3	2	3	2	2		2	1	3	3	-	1	3	3	1
CO 4	3	2	3	2	-	-	2	1	3	3	-	1	3	3	1
CO 5	3	2	3	2	2		2	1	3	3	-	1	3	3	1
CO 6	3	2	3	2	-	-	2	1	3	3	-	1	3	3	1

Correlation Levels:

Level	**Correlation**
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓
CO 6	✓	✓		✓

Mar Ivanios College (Autonomous)

<table>
<tr><td>Discipline</td><td colspan="5">MATHEMATICS</td></tr>
<tr><td>Course Code</td><td colspan="5">MIUK7DSEMAT407.1</td></tr>
<tr><td>Course Title</td><td colspan="5">Partial Differential Equations</td></tr>
<tr><td>Type of Course</td><td colspan="5">DSE</td></tr>
<tr><td>Semester</td><td colspan="5">VII</td></tr>
<tr><td>Academic Level</td><td colspan="5">400-499</td></tr>
<tr><td rowspan="2">Course Details</td><td>Credit</td><td>Lecture per week</td><td>Tutorial per week</td><td>Practical per week</td><td>Total Hours/Week</td></tr>
<tr><td>4</td><td>4 hours</td><td>-</td><td>-</td><td>4</td></tr>
<tr><td>Pre-requisites</td><td colspan="5">• Differential Equations</td></tr>
<tr><td></td><td colspan="5">Text:
Yehuda Pinchover and Jacob Rubinstein, An Introduction to Partial DifferentialEquations, Cambridge University Press, 2005.

References

1. I. Sneddon, Elements of Partial Differential Equations, Dover Publications, Inc., 2006.
2. D. Greenspan, Introduction to Partial Differential Equations, TMH Edition, 1961.
3. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley and Sons, 1995.</td></tr>
</table>

	4. K. S. Rao, *Introduction to Partial Differential Equations*, PHI Learning Pvt. Ltd.,2011. 5. K. S. Rao, *Introduction to Partial Differential Equations*, PHI Learning Pvt. Ltd.,2011.
Course Summary	The course provides students with a solid foundation in the theory and techniques of partial differential equations, preparing them to analyze and solve a wide range of differential equations encountered in science, engineering, and other fields.

Module	Unit	Content	Hrs
		First Order equations	
I	I	Introduction, quasi linear equations, the method of characteristics, examples of the characteristic method, the existence and uniqueness theorem, the Lagrange method, Conservation laws and shock waves, the eikonal equation, general nonlinear equations.	15
	The topics to be discussed in this module can be found in Chapter 2: Sections 2.1 – 2.9 *of* **the text.**		
	Second Order linear equations in two independent variables		
II	II	Introduction, classification, canonical form of hyperbolic equations, canonical form of parabolic equations, canonical form of elliptic equations, Introduction to one dimensional wave equation, canonical form and general solution, the Cauchy problem and d'Alembert's formula.	15

	The topics to be discussed in this module can be found in Chapter 3: Sections 3.1- 3.5; Chapter 4: Sections 4.1 - 4.3 *of* **the text.**		
		Method of separation of variables	
III	III	Domain of dependence and region of influence, the Cauchy problem for the nonhomogeneous wave equation, introduction to the method of separation of variables, Heat equation: homogeneous boundary condition, separation of variables for the wave equation, separation of variables for the nonhomogeneous equations.	15
	The topics to be discussed in this module can be found in Chapter 4: Sections 4.4, 4.5, Chapter 5: Sections 5.1 – 5.4 *of* **the text.**		
		Sturm – Liouville problems and eigen function expansions, Equations in high dimensions	
IV	IV	Introduction, the Sturm- Liouville problem, inner product spaces and orthonormal systems, basic properties of Sturm– Liouville eigen functions and eigenvalues, nonhomogeneous equations, nonhomogeneousboundary conditions. Introduction, first order equations, classification of second order equations, the wave equation in R^2 and R^3, the eigenvalue problem for the Laplace equation, separation of variables for the heat equation, separation of variables for the wave equation, separation of variables for the Laplace equation.	15
	The topics to be discussed in this module can be found in Chapter 6: Sections 6.1 – 6.6 and Chapter 9: Sections 9.1 – 9.8 of **the text .**		

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Employ the method of characteristics, and applyexistence and uniqueness theorem.	R, U, Ap, E	PSO-1,2,3, 4, 7, 8
CO-2	Analyze different types of second order partial differential equations along with their canonical forms..	R, U, Ap, E	PSO-1,2,3, 4, 7, 8
CO-3	Solve a PDE using the method of separation of variables.	R, U, Ap, E	PSO-1,2,3, 4,5, 7, 8
CO-4	Relate the beauty of Inner product spaces.	R, U, Ap, E	PSO-1,2, 3, 4, 7, 8
CO-5	Classify the second order partial differential equations and use the method of separation of variables.	R, U, Ap, E	PSO-1,2,3,4,5, 7, 8
CO-6	Interpret the physics and hence the applications behind all the standard second order partial differential equations.	R, U, Ap, E	PSO-1,2, 3, 4, 7, 8

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Note: 1 or 2 COs/module

Partial Differential Equations : Credits: 4:0:0 (Lecture: Tutorial: Practical)

CO No.	CO	PO/ PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)

CO1	Employ the method of characteristics, and applyexistence and uniqueness theorem.	PO-1,2, 4,5, 6, 7	R, U, Ap, E	F, C	L	
CO 2	Analyze different types of second differential equations along with their canonical forms.	PO-1,2, 4,5, 6, 7	R, U, Ap, E	F,P, M	L	
CO3	Solve a PDE using the method of separation of variables.	PO-1,2, 4,5, 6, 7	R, U, Ap, E	F, C, P	L	
CO 4	Relate the beauty of Inner product spaces..	PO-1,2, 4,5, 6, 7	R, U, Ap, C	F, P, M	L	
CO 5	Classify the second order partial differential equations and use the method of separation of variables.	PO-1,2, 4,5, 6, 7	R, U, An, C	P, M	L	
CO 6	Interpret the physics and hence the applications behind all the standard second order partial differential equations.	PO-1,2, 4,5, 6, 7	R, U, An, C	F, P, M	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
CO 1	3	2	3	2	-	-	2	1	3	3	-	1	3	3	1
CO 2	3	2	3	2	-	-	2	1	3	3	-	1	3	3	1
CO 3	3	2	3	2	2		2	1	3	3	-	1	3	3	1
CO 4	3	2	3	2	-	-	2	1	3	3	-	1	3	3	1
CO 5	3	2	3	2	2		2	1	3	3	-	1	3	3	1

CO 6	3	2	3	2	-	-	2	1	3	3	-	1	3	3	1

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓
CO 6	✓	✓		✓

MAR IVANIOS COLLEGE (AUTONOMOUS), THIRUVANANTHAPURAM
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