CMS COLLEGE KOTTAYAM
(AUTONOMOUS)

Affiliated to the Mahatma Gandhi University
Kottayam, Kerala

CURRICULUM FOR POST GRADUATE PROGRAMME

MASTER OF SCIENCE IN MATHEMATICS

UNDER CREDIT AND SEMESTER SYSTEM (CSS)
(With effect from 2019 Admissions)

Approved by the Board of Studies on 13th May 2019

CONTENTS

BOARD OF STUDIES

Dr. Varghese C. Joshua
Head of the Department
Department of Mathematics
CMS College Kottayam (Autonomous) (Chairman)

Dr. A. Krishnamoorthy
Professor Emiritus, Department of Mathematics
Cochin University of Science and Technology (External Expert)

Dr. P.B. Vinodkumar
Professor, Department of Mathematics
Rajagiri College of Engineering
Kalamasserry, Ernakulam (External Expert)

Dr. Varghese Jacob
Assistant Professor
Department of Mathematics
Govt. College Kottayam (University Nominee)

Dr.Shine C. Mathew
Associate Professor
SB College
Changanacherry (Alumni Representative)

Mr. Siby Chandy
DGM, SBI
Kottayam. (Beneficiary Representative)

Smt. Sreeja. K
Assistant Professor
Department of Mathematics
CMS College Kottayam (Autonomous) (Member)

Smt. Ambily P Mathew
Assistant Professor
Department of Mathematics
CMS College Kottayam (Autonomous) (Member)

Smt. Sindhu Thomas
Assistant Professor
Department of Mathematics
CMS College Kottayam (Autonomous) (Member)

Dr. Anooja. I
Assistant Professor
Department of Mathematics
CMS College Kottayam (Autonomous) (Member)

ACKNOWLEDGEMENTS

The development of this curriculum is the outcome of the involvement of various committed and specialised people at various stages.

Special mention must be made of the following to whom we are greatly indebted for their valuable guidance and contribution. Prof.(Dr.)N. J. Rao, Former Professor, Indian Institute of Science, Dr.T P. Sasi Kumar, Former Professor ISRO, and Dr.C.James, Associate Professor, Department of Physics, Scott Christian College, Nagercoil.

We are particularly grateful to the Principal, the IQAC and the Curriculum Revision Committee of CMS College for the excellent stewardship.

We thank our colleagues, academicians from other institutions, representatives from industry and representatives of other stakeholders for their cooperation, valuable suggestions and collective efforts.

Dr.Varghese C. Joshua
Chairman
Board of Studies

13.05.2019
Kottayam

PREFACE

“Mathematics is the language in which God has written the world.”
Galileo Galilei (1564-1642)
“For the things of this world canot be made known without a knowledge of mathematics.”
Roger Bacon (1219-1292)

CMS College is the pioneer of the modern higher education in India. Mathematics was a part of the curriculum right from the inception of the college and has a legacy of being one of the very few arenas were Euclid’s ‘Elements’ was taught to usher the age of modernity.

Mathematics runs in the veins of natural sciences. It is inextricably incorporated with world and with the natural phenomena. Mathematics has its own rich individuality and all branches of science have a deep and significant dependence or indispensible relation on Mathematics. Mathematics is a discipline of multiple perspectives.

Mathematics is exact, precise, systematic, and a logical subject. Mathematical theorems demystify physical phenomenon. They also explain the physical laws which govern the universe. A mathematical theorem is not accepted until a stringent proof has been produced for it. Acquiring the requisite precision is demanding, and continual practice is necessary.

Mathematics can be personally empowering in everyday life. Mathematics is one of the greatest cultural and intellectual achievements of humankind and every citizen ought to develop an appreciation and understanding of that achievement, including its aesthetic aspect. All careers require a foundation of mathematical knowledge.

Mathematics is also the language of all sciences. Mathematics plays the vital role in all scientific communications.

This is an era of rapid change and development. New knowledge, ideas, tools and ways of doing and communicating Mathematics continue to emerge and evolve. The level of mathematical thinking needed for problem solving in workplace has increased dramatically.

It is believed that there are ten values in learning mathematics. They are practical, intellectual, social, moral, disciplinary, cultural, international, aesthetic, vocational and psychological values. The programme and course outcomes are formulated and mapped based on these concepts. This curriculum identifies the key role of Mathematics in shaping the value based scientific society.

May more students pursue an excellent educational path that will prepare them for lifelong work as mathematicians and scientists.

REGULATIONS FOR POST GRADUATE PROGRAMMES UNDER CREDIT SEMESTER SYSTEM 2019

Preamble

CMS College Kottayam (Autonomous) was conferred with the Autonomous status as per UGC No.F.22-1/2016(AC) Dtd. 9th March 2016 and Mahatma Gandhi U.O.No.2732/VII/2016/Acad. Dtd.12th May 2016.

REGULATIONS

CMS College Kottayam (Autonomous) follows Credit Semester System (CSS) for the Post Graduate programmes from the Academic year 2019-20. The Post Graduate programmes of the college are being redesigned and revised in tune with the modifications effected at the UGC Curriculum Framework. This will be reflected in the scheme, course content and mode of examination and Evaluation system. The scheme and syllabus of all the programmes are being revised accordingly. The revisions were effected based on the recommendations made at the Curriculum Revision workshops conducted for the purpose besides several sittings of the Curriculum Revision Committee.

1. TITLE

1.1. These regulations shall be called **"CMS COLLEGE KOTTAYAM (AUTONOMOUS) REGULATIONS FOR POST GRADUATE PROGRAMMES UNDER CREDIT AND SEMESTER SYSTEM 2019"**

2. SCOPE

2.1 Applicable to all regular Postgraduate Programmes conducted by the CMS College Kottayam (Autonomous) with effect from 2019 admissions.

2.2 Medium of instruction is English unless otherwise stated therein.

3. DEFINITIONS

3.1. **Academic Week** is a unit of five working days in which the distribution of work is organized from day one to day five, with five contact hours of one hour duration on each day.

3.2. **Semester** means a term consisting of **90** working days, within **18** five-day academic weeks for teaching, learning and evaluation.

3.3. **Programme** means a two year programme of study and examinations, spread over four semesters, with a set of courses, the successful completion of which would lead to the award of a degree.

3.4. **Course** comprises a set of classes or a plan of study on a particular subject which will be taught and evaluated within a semester of a study programme.

3.5. **Core course** means a course which should compulsorily be studied by a student as requirement in the subject of specialization within a degree programme.

3.6. **Elective Course** means an elective course chosen from the discipline/ subject, in an advanced area.

3.7. **Credit** is the numerical value assigned to a course according to the duration of the classes or volume of the syllabus of the course**.**

3.8. **Department** means any teaching department in the college.

3.9. **Dean of Academic Affairs** is a teacher nominated by the Academic Council to coordinate the academic affairs of the college relating to academic planning, curriculum implementation and review.

3.10. **Dean of Student Affairs** is a teacher nominated by the Academic Council to coordinate the admissions, grievances and other student related services.

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

3.12. **Department Coordinator** is a teacher nominated by a Department Council to co-ordinate the [In]-Semester examination of the PG programme in that department.

3.13. **Faculty Advisor** means a teacher from the parent department nominated by the Department Council, who will advise the students of a class on academic matters.

3.14. **Course Teacher** means a teacher who is in charge of a course. If a course is taught by more than one teacher, one teacher should be assigned as course teacher, nominated by the HOD. The course teacher shall be responsible for the valuation of answer scripts of examinations and other continuous assessments.

3.15. **In-Semester Assessment (ISA)** means assessment consisting of Attendance, Assignment/Seminar/Viva voce and Examination (theory and practical).

3.16. **End Semester Assessment (ESA)** means Examination conducted at the end of each semester for all courses (theory and practical).

3.17. **Internal Examiner** means a teacher working in the college.

3.18. **External Examiner** means a teacher from outside the college.

3.19. **Grace Marks** shall be awarded to candidates as per the orders issued by Mahatma Gandhi University.

3.20. **Grade** means a letter symbol (A, B, C, etc.), which indicates the broad level of performance of a student in a Course/ Semester/Programme.

3.21. **Grade Point** (GP) is the numerical indicator of the percentage of marks awarded to a student in a course.

3.22. **College Average (CA)** means average mark secured (ISA+ESA) for a course at the college level.

3.23. Words and expressions used and not defined in this regulation shall have the same meaning assigned to them in the Act and Statutes of the University, UGC Regulations and the Constitution of the CMS College Kottayam (Autonomous).

4. ELIGIBILITY FOR ADMISSION AND RESERVATION OF SEATS

Eligibility for admission, norms for admission and reservation of seats for various Postgraduate Programmes shall be according to the regulations framed/orders issued by Govt. of Kerala, Mahatma Gandhi University and CMS College Kottayam in this regard.

5. PROGRAMME STRUCTURE

5.1 The nomenclature of all PG programmes shall be as per the specifications of University Grants Commission and the Mahatma Gandhi University.

5.2 Credit Semester System (CSS) will be followed for all PG Programmes from the academic year 2019– 2020.

5.3 All the PG Programmes will be of two-year duration with four Semesters. A student may be permitted to complete the Programme, on valid reasons, within a period of 8 continuous semesters from the date of commencement of the first semester of the programme.

5.4 There will be three/four/five courses in each semester and one viva voce and dissertation at the end of the fourth semester.

5.5 There will be three components for the programme viz. core course, elective course and project spread over four semesters.

5.6 The total credits required for completing a PG Programme is **80**.

5.7 The Syllabus for all courses in each semester has been divided into five modules based on certain thematic commonalities.

6. EVALUATION SYSTEM

i. The evaluation scheme for each course shall contain two parts:
(a) In-Semester Assessment (ISA)
(b) End-Semester Assessment (ESA)

ii. The proportion of ISA to ESA will be 1:3.

iii. The marks secured for each course shall be converted as grades. The grades for different semesters and overall programme are assigned based on the corresponding semester grade point average and cumulative grade point average respectively.

iv. A separate minimum of 40% is mandatory for both ISA and ESA to pass for every course.

6.1 EVALUATION OF THEORY COURSES

The marks allotted for theory courses in End-Semester Assessment shall be 120 and that for the In-Semester Assessment will be 40.

A. IN-SEMESTER ASSESSMENT

The In-semester assessment for theory is based on the marks obtained for Attendance, Assignment, Major Seminar and two Test Papers for a particular course.

(i) Attendance

Percentage of attendance	**Mark**
90 and above	6
85 - 89	5
80 - 84	4
76 - 79	3
75	2
Below 75	0

Maximum marks = 6

(ii) Assignment (One assignment per course)

Evaluation Component	**Mark**
Review of related literature	2
Content	3
Reference	2
Punctuality	1

Maximum marks = 8

(iii) Major Seminar

A student should present one Major Seminar in a Semester. The faculty advisor should allot students to the respective course teacher in a semester. The seminar topics shall be incorporated in the syllabus for each course/ declared in the beginning of each semester. The student shall prepare the seminar paper with the guidance of the course teacher. The student is expected to make a detailed presentation in a common session in the department, with students and all course teachers. The student shall also make a brief conclusion including the future scope of studying the topic. The teacher in charge of the particular course has to act as the moderator for the seminar.

The course teachers of that semester shall evaluate the seminar and give marks for their course or the average mark of all the evaluators shall be taken as the seminar mark for each course of a semester.

Evaluation Component	**Mark**
Involvement/punctuality	1
Review of related literature	1
Content	3
Presentation	3
Interactions/ justification	1
Conclusion	1

Maximum marks = 10

(iv) Test paper

For each course, two In-Semester examinations of total 16 marks shall be conducted. One of the test paper will be centralized examination of 8 marks and the remaining 8 marks will be awarded with one or more class tests conducted by the course teacher.

B. END -SEMESTER ASSESSMENT

End-Semester examinations for each course are conducted at the end of every semester with a maximum marks of 120. The examination for each course will have two components viz., descriptive test and an objective type test. Questions shall be set to evaluate the attainment of course outcomes. The question paper for each course will be generated from the Question Bank which is prepared by due mapping of Course outcomes and Program Specific Outcomes.

(i) Descriptive Test

A written examination with a maximum marks of 100 and of three hours duration will be conducted.

PATTERN OF QUESTIONS

A question paper shall be a judicious mix of short answer type, short essay/problem solving type and long essay type questions.

No.	Section	Type of questions	Total Questions	Number of questions to be answered	Mark for each question	Total Marks
1	Section A	Short answer type	8	5	4	20
2	Section B (One pair should be from each module)	Short essay/problem solving type	10 (Either/or)	5	8	40
3	Section C	Long essay type	4	2	20	40
	Total		**22**	**12**	**-**	**100**

(ii) Objective Test

A Multiple Choice Objective type Test shall be a component of the End-semester examination which will be conducted in the online mode for each course. The marks obtained shall be converted into 20. The objective type examination for all courses in a semester shall be conducted in a session of one hour. The number of questions in Arts stream will be 50 and that of Science and Mathematics stream will be 40.Questions should be equally distributed among the courses in a semester.

There will be four choices for each question. Each question carries 4 marks for correct answer, zero marks for no answer and -1 marks for wrong answer.

6.2 EVALUATION OF PRACTICAL COURSES

Practical examination will be conducted at the end of each semester/ end of an academic year. The time of conduct of the practical examination will be decided by the respective BOS.

A. **IN-SEMESTER ASSESSMENT**

Evaluation Component	Mark
Attendance	6
Lab Involvement	8
Test	12
Record	8
Viva	6

Maximum Marks = 40

The components and the marks can be modified by the concerned BOS/Expert committee within the limit of maximum marks.

B. **END- SEMESTER ASSESSMENT**

Evaluation Component	Mark
Attendance	18
Lab Involvement	24
Test	36
Record	24
Viva	18

Maximum Marks = 120

The components and the marks can be modified by the concerned BOS/Expert committee within the limit of maximum marks.

6.3 EVALUATION OF PROJECT

An academic project work shall be done and a dissertation shall be submitted in the final semester of the programme. There will be both In semester and End semester assessment for the project work.

A. **IN- SEMESTER ASSESSMENT**

Evaluation Component	Mark
Relevance of the topic	5
Project content and report	15
Presentation	15
Project viva	10
Paper presentation* in Seminar/Conference or publications with ISBN/ISSN (*valid certificate to be submitted)	5

Maximum marks = 50

The components and the marks can be modified by the concerned BOS/Expert committee within the limit of maximum marks.

B. **END -SEMESTER ASSESSMENT**

The dissertation at the end of final Semester will be evaluated by a panel of one internal evaluator assigned by HOD and one external evaluator / a panel of two external evaluators, as may be decided by the respective BOS.

Evaluation Component	**Mark**
Relevance of the topic	15
Project content and report	45
Presentation	45
Project viva	30
Paper presentation* in Seminar/Conference or publications with ISBN/ISSN (*valid certificate to be submitted)	15

Maximum marks = 150

The components and the marks can be modified by the concerned BOS/Expert committee within the limit of maximum marks.

6.4 EVALUATION OF COMPREHENSIVE VIVA VOCE

A comprehensive viva voce shall be done at the end of the final semester. There will be both In-semester and End-semester assessment for the viva voce examination.

A. IN - SEMESTER ASSESSMENT

Evaluation Component	**Mark**
+2/ UG level questions	4
PG syllabus level questions	10
Subject of interest based questions	8
Advanced level questions	3

Maximum marks = 25

The components and the marks can be modified by the concerned BOS/Expert committee within the limit of maximum marks.

B. END- SEMESTER ASSESSMENT

The comprehensive Viva Voce Examination at the end of final Semester will be evaluated by a panel of one internal evaluator assigned by HOD and one external evaluator / a panel of two external evaluators, as may be decided by the respective BOS.

Evaluation Component	**Mark**
+2/ UG level questions	12
PG syllabus level questions	30
Subject of interest based questions	24
Advanced level questions	9

Maximum marks = 75

The components and the marks can be modified by the concerned BOS/Expert committee within the limit of maximum marks.

7. Grievance Redressal Mechanism

In order to address the grievance of students regarding In-Semester assessment, a two-level Grievance Redressal mechanism is established.

Level 1: Department Level: The Department cell is chaired by the HOD, Department Coordinator as member secretary and Course teacher in-charge as member. If the grievance is not redressed at the Department level, the student shall report the grievance to the College Level Grievance Redressal Cell.

Level 2: **College level**: College Level Grievance Redressal Cell has the Vice-Principal as the Chairman, Dean of Student Affairs as the Member Secretary and HOD of concerned Department as member.

8. Eligibility for End Semester Examination

A minimum of 75% average attendance for all the courses is mandatory to register for the examination. Condonation of shortage of attendance to a maximum of 10 days in a semester subject to a maximum of 2 times during the whole period of the programme may be granted by the College on valid grounds. Attendance may be granted to students attending University/College union/Co-curricular activities for the days of absence, on production of participation/attendance certificates, within one week, from the teacher in charge of the activity and endorsed by the Dean of Student Affairs. This is limited to a maximum of 10 days per semester. Monthly Attendance report will be published in the college website on or before the 10th of every month. Those students who are not eligible even with condonation of shortage of attendance shall repeat the semester along with the next batch after obtaining readmission.

9. Promotion to the next Semester

Those students who possess the required minimum attendance and have registered for the End Semester Examination during an academic semester are promoted to the next semester.

Those students who possess the required minimum attendance and progress during an academic semester and could not register for the semester examination are permitted to apply for Notional Registration to the examinations concerned enabling them to get promoted to the next semester.

10. Eligibility for Readmissions

An additional chance of readmission will be given to those students who could not register for the examination due to shortage of attendance. Readmitted students shall continue their studies with the subsequent batch of students. If an applicant for readmission is found to have indulged in ragging or any other misconduct in the past, readmissions shall be denied.

11. MARK CUM GRADE CARD

The College under its seal shall issue to the student a MARK CUM GRADE CARD on completion of each semester/programme, which shall contain the following information:

(a) Name of the College
(b) Title of the Postgraduate Programme
(c) Name of the Semester
(d) Name and Register Number of the student
(e) Date of publication of result
(f) Code, Title, Credits and Maximum Marks (ISA, ESA & Total) of each course opted in the semester.
(g) ISA, ESA and Total Marks awarded, Grade, Grade point and Credit point in each course opted in the semester
(h) College average (CA) of the marks of all courses
(i) The total credits, total marks (Maximum & Awarded) and total credit points in the semester
(j) Semester Grade Point Average (SGPA) and corresponding Grade.
(k) Cumulative Grade Point Average (CGPA) and corresponding Grade.

The final Mark cum Grade Card issued at the end of the final semester shall contain the details of all courses taken during the study programme and the overall mark/grade for the total programme.

There shall be a College Level Monitoring Committee comprising Principal, Vice Principal as member-secretary, Dean of Academic Affairs, Controller of Examinations, IQAC Director and Administrative Assistant as members for the successful conduct of the scheme.

12. CREDIT POINT AND CREDIT POINT AVERAGE

Credit Point (CP) of a course is calculated using the formula:-
CP = C × GP, where C is the Credit and GP is the Grade point

Semester Grade Point Average (SGPA) of a Semester is calculated using the formula:-
SGPA = TCP/TC, where TCP is the Total Credit Point of that semester, ie, $\sum_1^n \mathrm{CPi}$*; TC is the Total Credit of that semesterie,* $\sum_1^n \mathrm{Ci}$, *where n is the number of courses in that semester*

Cumulative Grade Point Average (CGPA) is calculated using the formula:-
CGPA = TCP/TC, where TCP is the Total Credit Point of that programmeie, $\sum_1^n \mathrm{CPi}$*; TC is the Total Credit of that programme, ie,* $\sum_1^n \mathrm{Ci}$ *, where n is the number of courses in that programme*

Grades for the different courses, semesters and overall programme are given based on the corresponding CPA as shown below:

CPA	Grade with Indicator
4.5 to 5.0	A+ Outstanding
4.0 to 4.49	A Excellent
3.5 to 3.99	B+ Very Good
3.0 to 3.49	B Good (Average)
2.5 to 2.99	C+ Fair
2.0 to 2.49	C Marginal
Up to 1.99	D Deficient (Fail)

13. TRANSITORY PROVISION

Notwithstanding anything contained in these regulations, the Principal shall, for a period of six months from the date of coming into force of these regulations, have the power to provide by order that these regulations shall be applied to any programme with such modifications as may be necessary.

The Principal is also authorized to issue orders for the perfect realization of the regulations.

Annexure I
(Model Mark Cum Grade Card)

CMS COLLEGE KOTTAYAM (AUTONOMOUS)
Affiliated to Mahatma Gandhi University Kottayam
(Autonomous College as per UGC order no.F.22-1/216(AC)dated 9th March 2016)

MARK CUM GRADE CARD

Section :
Name of the Candidate :
Unique Permanent Registration Number :
Degree :
Programme :
Stream :
Name of the Examination :
Date of Publication of Result :

Course Code	Course Title	Credits (c)	Marks						Grade Awarded (G)	Grade Point (GP)	Credit Point (C x	College Average	Result
			ISA		ESA		TOTAL						
			Awarded	Maximum	Awarded	Maximum	Awarded	Maximum					

ISA - In - Semester Assessment, ESA – End - Semester Assessment

SGPA: **SG:**

Checked by **Section Officer** **Controller of Examinations**

Date:

Annexure II

CMS COLLEGE KOTTAYAM (AUTONOMOUS)

Kerala, India – 686 001Website: www.cmscollege.ac.in
e-mail:kottayamcmscollege@gmail.com Tel: 91-481-2566002, Fax: 91-481-2565002
Affiliated to Mahatma Gandhi University Kottayam, Kerala
(Autonomous College as per UGC Order No.F.22-1/216 (AC) dated 9th March 2016)

CONSOLIDATED MARK CUM GRADE CARD

PHOTO

Name of the Candidate:

Unique Permanent Register Number (UPRN):

Degree:

Programme:

Stream:

Date of Birth:

Date of Eligibility for the Degree:

CMS COLLEGE KOTTAYAM (AUTONOMOUS)

Name: UPRN:

Course Code	Course Title	Credits (C)	Marks						Grade Awarded (G)	Grade Point	Credit Point (CxGP)	College Average (CA)	Result
			ESA		ISA		Total						
			Awarded	Maximum	Awarded	Maximum	Awarded	Maximum					

Final Result

Cumulative Grade Point Average CGPA :

Semester Summary

Sl.No	Semester	Credit	SGPA	Grade	Month/year	Result
	Semester 1					
	Semester 2					
	Semester 3					
	Semester 4					

Date: **Controller of Examinations**

Annexure III

(Reverse side of the Mark cum Grade Card (COMMON TO ALL SEMESTERS))

Description of the Evaluation Process

Grade and Grade Point

The Evaluation of each Course comprises of Internal and External Components in the ratio 1:3 for all Courses.

Grades and Grade Points are given based on the percentage of Total Marks (Internal + External) as given in Table 1

(Decimals are to be rounded mathematically to the nearest whole number)

Table 1

% Marks	Grade	GP
Equal to 88 and above	A+ Outstanding	5
Equal to 76 and < 88	A Excellent	4
Equal to64 and < 76	B+ Very Good	3
Equal to 52 and < 64	B Good(Average)	2
Equal to 40 and below 52	C Marginal	1
Below 40	D Deficient (Fail)	0
	Ab Absent	

Credit point and Credit point average

Grades for the different Semesters and overall Programme are given on a 7-point Scale based on the corresponding CPA, as shown in Table 2.

Table 2

CPA	Grade with Indicator
4.5 to 5.0	A+ Outstanding
4.0 to 4.49	A Excellent
3.5 to 3.99	B+ Very Good
3.0 to 3.49	B Good (Average)
2.5 to 2.99	C+ Fair
2.0 to 2.49	C Marginal
Up to 1.99	D Deficient (Fail)

Credit point (**CP**) of a paper is calculated using the formula $CP = C \times GP$,**where C is the Credit; GP is the Grade Point**

Semester or Programme (cumulative) Grade Point Average of a Course/Programme is calculated using the formula

SGPA/CGPA = $\frac{TCP}{TC}$**, where TCP is the Total Credit Point; TC is the Total Credit**

NOTE

A separate minimum of 40% marks each for internal and external (for both theory and practical) are required for a pass for a course. For a pass in a programme, a separate minimum of **Grade C** is required for all the individual courses. If a candidate secures **D Grade** for any one of the course offered in a Semester/Programme **only D grade** will be awarded for that Semester/Programme until he/she improves this to **C GRADE** or above within the permitted period.

CURRICULUM

GRADUATE PROGRAMME OUTCOMES (GPO) – POST GRADUATE PROGRAMMES

At the completion of the Post Graduate Programme, the student will be able to accomplish the following programme outcomes.

GPO.1	**Critical Thinking**: Ability to engage in independent and reflective thinking in order to understand logic connections between ideas.
GPO.2	**Effective Communication:** Development of communication skills for effectively transmitting and receiving information that focuses on acquiring knowledge, problem solving, improving on arguments and theories thereby paving the way for better employability and entrepreneurship.
GPO.3	**Social Consciousness:** Acquire awareness towards gender, environment, sustainability, human values and professional ethics and understand the difference between acting, responding and reacting to various social issues.
GPO.4	**Multidisciplinary Approach:** Combining various academic disciplines and professional specializations to cross borders and redefine problems in order to explore solutions based on the new understanding of complex situations.
GPO.5	**Subject Knowledge:** Acquiring knowledge at a higher level that would help develop the necessary skills, fuel the desire to learn and contribute to the field of expertise thereby providing valuable insights into learning and professional networking with the aim of catering to the local, national and global developmental needs.
GPO.6	**Lifelong Learning**: Understanding the necessity of being a lifelong learner for personal enrichment, professional advancement and effective participation in social and political life in a rapidly changing world.

PROGRAMME SPECIFIC OUTCOMES (PSO)

IO No.	**Intended Programme Specific Outcomes** *Upon completion of M.Sc Mathematics Programme, the graduates will be able to:*	GPO No.
PSO-1	Provide high quality education in higher mathematics committed to excellence in research.	3,4,5,6
PSO-2	Encourage students to develop the skills in objectivity, creativity, independent thinking and analyzing.	1,5
PSO-3	Enhance the ability of abstraction as the core concept of modern mathematics.	1,2
PSO-4	Innovate, invent and solve complex mathematical problems.	1,5
PSO-5	Enhance problem solving and computing skills.	3,5
PSO-6	Acquire the ability to engage in independent and life long learning in the broadest context of physical, social and technological changes.	3,6
PSO-7	Explain and transform the physical problems using the knowledge of mathematical theories and appreciate the research on such issues.	4,5

PROGRAMME DESIGN

The Post graduate programme in Mathematics is a two year programme of four semesters. There are four components for the programme namely, the core course, elective course, viva-voce and a major project. In the first three semesters there are five core courses. In the fourth semester, there are one core course, four elective courses, a major project and a comprehensive viva-voce. The total credits for completing MSc programme in Mathematics are 80.

The Course Design is given below:

Sl No	Course Type	No of courses	Total credits
1.	Core courses	16	64
2.	Elective courses	4	16
3.	Viva -voce	1	2
4.	Project	1	3
	TOTAL	**22**	**80**

PROGRAMME STRUCTURE

	Code	Course	Hours/ Week	Total Hours	Credits
Semester 1	MT1921101	Linear Algebra	5	90	4
	MT1921102	Basic Topology	5	90	4
	MT1921103	Measure Theory and Integration	5	90	4
	MT1921104	Graph Theory	5	90	4
	MT1921105	Complex Analysis	5	90	4
		Total			**20**
Semester 2	MT1922106	Abstract Algebra	5	90	4
	MT1922107	Advanced Topology	5	90	4
	MT1922108	Advanced Complex Analysis	5	90	4
	MT1922109	Partial Differential Equations	5	90	4
	MT1922110	Real Analysis	5	90	4
		Total			**20**
Semester 3	MT1923111	Multivariate Calculus and Integral Transforms	5	90	4
	MT1923112	Functional Analysis	5	90	4
	MT1923113	Differential Geometry	5	90	4
	MT1923114	Number Theory and Cryptography	5	90	4
	MT1923115	Optimization Techniques	5	90	4
		Total			**20**
Semester 4	MT1924116	Spectral Theory	5	90	3
	MT1924301	Analystic Number Theory	5	90	3
	MT1924302	Combinatorics	5	90	3
	MT1924303	Operations Research	5	90	3
	MT1924304	Algorithmic Graph Theory	5	90	3
	MT1924801	Project			3
	MT1924901	Viva			2
		Total			**20**
		GRAND TOTAL			**80**

DETAILED SYLLABUS OF ALL COURSES

SEMESTER I

Course	Details				
Code	MT1921101				
Title	**LINEAR ALGEBRA**				
Degree	M.Sc				
Branch(s)	Mathematics				
Year/Semester	1/I				
Type	Core				
Credits	4	Hrs/Week	5	Total Hours	90

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Analyze finite and infinite dimensional vector spaces and subspaces over a field and their properties, including the basis structure of vector spaces	An	3
2	Use the definition and properties of linear transformations and matrices of linear transformations and change of basis, including kernel, range and isomorphism	Ap	4, 5
3	Compute with the characteristic polynomial, eigenvectors, eigenvalues and eigenspaces, as well as the geometric and the algebraic multiplicities of an eigenvalue and apply the basic diagonalization result	Ap	5
4	Understand the basic thoery of Simultaneous triangulations, Direct sum decompositions and Invariant direct sums	U	6
5	Realize how linear algebra uses and unifies ideas for functional analysis, the spectral theory.	U	7

PSO – Programme Specific Outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO.No.
1.0	**Module 1**		
1.1	Vector spaces	3	1,5
1.2	subspaces	3	1,5
1.3	basis and dimension	3	1,5
1.4	Co-ordinates	3	1
1.5	Summary of row-equivalence	3	1

2.0	**Module 2**		
2.1	Linear transformations	4	2,5
2.2	The algebra of linear transformations	5	2
2.3	Isomorphism	4	2
2.4	Representation of transformations by matrices	5	2,5
3.0	**Module 3**		
3.1	Linear functionals	4	2,5
3.2	Double dual	4	2
3.3	Transpose of a linear transformation	4	2
4.0	**Module 4**		
4.1	Commutative Rings	4	3,5
4.2	Determinant functions	5	3,5
4.3	Permutation and uniqueness of determinants	5	3
4.4	Additional properties of determinants	4	3
5.0	**Module 5**		
5.1	Introduction to elementary canonical forms	3	4,5
5.2	Characteristic Values	4	4,5
5.3	Annihilating polynomials	3	4
5.4	Invariant subspaces	3	4,5
5.5	Simultaneous triangulations	3	4
5.6	Simultaneous diagonalisation	3	4
5.7	Direct sum decompositions	4	4
5.8	Invariant direct sums	4	4

Text Books:

1. Kenneth Hoffman / Ray Kunze (Second Edition), Linear Algebra, Prentice-Hall of India Pvt. Ltd., New Delhi, 1992.

Module 1:
Chapter 2 - 2.1, 2.2, 2.3 of the text (Proof of theorems excluded)
Chapter 2 - 2.4 & 2.5 of the text (15 hours.)

Module 2:
Chapter 3 - 3.1, 3.2, 3.3 & 3.4 of the text (18 hours.)

Module 3:
Chapter 3 - 3.5, 3.6 & 3.7 of the text (12 hours.)

Module 4:
Chapter 5 - 5.1, 5.2, 5.3 & 5.4 of the text (18 hours.)

Module 5:
Chapter 6 - 6.1, 6.2, 6.3, 6.4, 6.5 & 6.6 of the text (27 hours.)

Text Books for Reference

1. Klaus Jonich. Linear Algebra, Springer Verlag.
2. Paul R. Halmos, Linear Algebra Problem Book, The Mathematical Association of America.
3. S. Lang, Algebra, 3rd edition, Addison-Wesley, 1993.
4. K.B. Datta, Matrix and Linear Algebra, Prentice Hall of India Pvt. Ltd., New Delhi, 2000.
5. S. Kumaresan, Linear Algebra A Geometrical Approach, Prentice Hall of India, 2000.

Course	Details				
Code	MT1921102				
Title	**BASIC TOPOLOGY**				
Degree	M.Sc				
Branch(s)	Mathematics				
Year/Semester	1/I				
Type	Core				
Credits	4	Hrs/Week	5	Total Hours	90

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Analyze the transition from metric spaces to topological spaces	An	2,3
2	Investigate whether a given family of subsets is a topology or not	E	2,3,4,7
3	Understand and apply relationship between base and sub base of a topology	An	2,3
4	Examine how various basic concepts are generalised from metric spaces to topological spaces	Ap	2,3,4
5	Discuss various problems related to quotient topology and suggest solutions.	An	1,2,3
6	Describe various smallness conditions defined in topological spaces.	U	3,6
7	Distinguish between connected and disconnected spaces.	Ap	2,3
8	Understand the concepts of local connectedness and path connectedness.	U	3,4
9	Explain the concept of separation axioms	U	3
10	Apply the characterisations of various separation axioms	An	3,4

PSO – Programme Specific Outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO.No.
1.0	**TOPOLOGICAL SPACES – INTRODUCTION** [Chapter 4 Section – 1, 2, 3, 4]	20	
1.1	Definition of a topological space	4	1,2,3
1.2	Examples of topological spaces	5	1,2,3
1.3	Bases	4	1,3,4
1.4	Sub bases	3	1,3,4
1.5	Sub spaces	4	3,4
2.0	**BASIC CONCEPTS** [Chapter 5 Section -1 and 2 of the text; 5.2.11 & 5.2.12 excluded.]	20	
2.1	Closed sets	4	1,4
2.2	Closure	5	1,4
2.3	Neighborhood	5	1,4

2.4	Interior points	3	1,4
2.5	Accumulation points	3	1,4
3.0	**CONTINUITY AND RELATED CONCEPTS** [Chapter 5- Section 3 and 4 ; 5.3.2(4) excluded Chapter 6 Sec. 1 of the text]	20	
3.1	Definition of continuity	3	1,4
3.2	Characterisations	5	1,4
3.3	Making functions continuous	5	1,4,5
3.4	Quotient Spaces	3	1,4,5
3.5	Smallness condition on a space	4	1,4,6
4.0	**CONNECTEDNESS** [Chapter 6 Section. 2 & 3 of the text]	15	
4.1	Connectedness	5	1,4,7
4.2	Local connectedness	6	1,4,8
4.3	Paths	4	1,4,8
5.0	**SEPARATION AXIOMS** [Chapter – 7 Section 1 & 2; 2.13 to 2.16 of section 2 excluded]	15	
5.1	Separation axioms - definitions	4	1,4,9
5.2	Hierarchy of separation axioms	5	1,4,9,10
5.3	Compactness and separation axioms	6	1,4,9,10

Text Books:

K.D. Joshi, Introduction to General Topology, Wiley Eastern Ltd,1984.

Text Books for Reference

1. Munkres J.R, Topology-A First Course, Prentice Hall of India Pvt. Ltd., New Delhi, 2000.
2. J.L Kelley, General Topology, Van Nostrand, Reinhold Co., New York, 1995.
3. Stephen Willard, General Topology, Addison-Wesley.
4. Dugundji, Topology, Universal Book Stall, New Delhi.
5. George F Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill Book Company, 1963.

Course	Details				
Code	MT1921103				
Title	**Measure Theory and Integration**				
Degree	M.Sc				
Branch(s)	Mathematics				
Year/Semester	1/I				
Type	Core				
Credits	4	Hrs/Week	5	Total Hours	90

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Remember algebra of sets, open and closed sets of real numbers	R	6
2	Understand and analyze outer measure and measurable sets	An	2,3
3	Understand and analyze Lebesgue measre and measure space	An	2,3
4	Understand and analyze a measurable function	An	2,3
5	Remember Riemann Integral and apply	An	5,6
6	Understand and analyze Lebesgue Integral	An	2,3
7	Undersatand differentiation of monotone functions and apply	Ap	4
8	Understand the general concept of Lebesgue Integral	An	2,3
9	Understand signed measure analyze and apply related theorems	An	3
10	Understand and analyze convergence in measure	An	2,3
11	Extend the measurability in product space and analyze the related theorems	E	1,2,3

PSO – Programme Specific Outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO.No.
1.0	**Module 1**		
1.1	Algebra of sets, the axiom of choice and infinite direct products, open and closed sets of real numbers	5	1
1.2	Outer measure	5	2
1.3	Measurable sets	4	2
1.4	Lebesgue measure	4	3
1.5	A non-measurable set	2	2
2.0	**Module 2**		
2.1	Measurable functions	3	4

2.2	Riemann Integeral	2	5
2.3	Lebesgue integral of a bounded function over a set of finite measures	5	6
2.4	Integral of a non-negative function	3	6
2.5	General Lebesgue integral	5	8
3.0	**Module 3**		
3.1	Differentiation of monotone functions.	5	7
3.2	Measure Spaces	3	3
3.3	Measurable functions	3	4
3.4	Integration	4	8
3.5	General Convergene theorems	5	8
4.0	**Module 4**		
4.1	Signed Measures	3	9
4.2	Radon-Nikodym theorem	3	9
4.3	Outer measure and measurability	3	2
4.4	The extension theorem	3	9
5.0	**Module 5**		
5.1	Convergence in measure	5	10
5.2	Almostuniform convergence	5	10
5.3	Measurability in a product space	5	11
5.4	The product measure and Fubini's theorem	5	11

Text 1: **H.L. Royden, Real Analysis, Third edition, Prentice Hall of India Private Limited.**

Text 2: **G. de Barra, Measure Theory and Integration, New Age International (P) Linnilect Publishers.**

Module 1:
(Chapter 1 - section 4, 5)
(Chapter 2 - section 5)
(Chapter 3 - Sec. 1 to 4.) (Text 1) (20 hours.)

Module 2:
(Chapter 3. Section 5)
(Chapter 4. Sec 1 -4) (Text 1) (18 hours.)

Module 3:
(Chapter 5. Sec 1.)
(Chapter 11, Sec 1 -6) (Text 1) (20 hours.)

Module 4:
(Chapter 12 Sec 1 &2) (Text 1) (12 hours.)

Module 5:
(Chapter 8 - Sec. 7.1 & 7.2 of Text 2)
(Chapter 10 - Sec. 10.1& 10.2 of Text 2) (20 Hours)

References:-

1. Halmos P.R, Measure Theory, D.van Nostrand Co.
2. P.K. Jain and V.P. Gupta, Lebesgue Measure and Integration, New Age International
   (P) Ltd., New Delhi, 1986(Reprint 2000).
3. R.G. Bartle, The Elements of Integration, John Wiley & Sons, Inc New York, 1966.
4. Inder K Rana, An Introduction to Measure and Integration, Narosa Publishing House, 1997.

Course	Details				
Code	MT1921104				
Title	**Graph Theory**				
Degree	M.Sc				
Branch(s)	Mathematics				
Year/Semester	1/I				
Type	Core				
Credits	4	Hrs/Week	5	Total Hours	90

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Explain the basic concepts of graph theory.	U	1, 3
2	Solve problems using basic graph theory.	Ap	5
3	Identify induced subgraphs, cliques, vertex cuts, edge cuts, connectivity, spanning trees, independent sets and covers in graphs.	An	2
4	Model and solve real world problems using graph theory.	An	2, 5, 7
5	Determine whether graphs are Hamiltonian and/or Eulerian.	An	5
6	Solve problems involving vertex and edge colouring.	Ap	2, 5
7	Solve problems involving vertex and edge connectivity and Planarity.	Ap	2, 5

PSO – Programme Specific Outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO.No.
1.0	**Basic Results, Directed Graphs and Connectivity**	20	
1.1	Basic concepts, Subgraphs and Degrees of vertices	4	1
1.2	Paths and Connectedness	2	1
1.3	Automorphism of a simple graph	2	1
1.4	Line graphs	2	1
1.5	Basic concepts and Tournaments	3	1
1.6	Vertex cuts and Edge cuts.	2	3
1.7	Connectivity and Edge connectivity	3	3, 7
1.8	Blocks	2	3, 7
2.0	**Trees**	20	
2.1	Definition, characterization and simple properties	6	1
2.2	Centres and Cenroids	4	1, 2
2.3	Counting the number of spanning trees	2	2, 3

2.4	Cayley's formula	2	3
2.5	Applications	6	4
3.0	**Independent Sets, Eulerian Graphs and Hamiltonian Graphs**	17	
3.1	Vertex independent sets and vertex coverings	4	3
3.2	Edge independent sets	4	3
3.3	Eulerian graphs	5	5
3.4	Hamiltonian graphs	4	5
4.0	**Vertex Colourings and Edge Colourings**	17	
4.1	Vertex colourings	5	6
4.2	Critical graphs	3	1
4.3	Triangle free graphs	3	1
4.4	Edge colouring of graphs	6	6
5.0	**Planarity**	16	
5.1	Planar and non planar graphs	3	7
5.2	Euler formula and its consequences	4	7
5.3	K5 and K3,3 are non planar graphs	3	7
5.4	Dual of a plane graph	3	1, 7
5.5	The four colour theorem and Heawood five colour theorem	3	7

Text Books

1. **R.Balakrishnan and K. Ranganathan, A Text book of Graph Theory, Springer**

Chapter 1 Sections 1.1 to 1.5 and 1.6 (Up to 1.6.3)
Chapter 2 Sections 2.1 and 2.2
Chapter 3 Sections 3.1 to 3.3
Chapter 4 Sections 4.1 to 4.4
Chapter 10 Sections 10.1 to 10.4
Chapter 5 Sections 5.1 and 5.2
Chapter 6 Sections 6.1 and 6.2
Chapter 7 Sections 7.1 to 7.4
Chapter 8 Sections 8.1 to 8.5 of the text

Text Books for Reference

1. John Clark and Derek Allan Holton, A First Look at Graph Theory, Allied Publishers.
2. Douglas B West, Introduction to Graph Theory, Prentice Hall of India
3. F.Harary, Graph Theory, Addison-Wesley, 1969.

Course	Details				
Code	MT1921105				
Title	**Complex Analysis**				
Degree	M Sc.				
Branch(s)	Mathematics				
Year/Semester	1/I				
Type	Core				
Credits	4	Hours/week	5	Total Hours	90

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to:*	Cognitive Level	PSO No.
1	Identify analytic functions as mappings	U	3
2	Evaluate complex Integration	E	3,6
3	Determining the nature of singularities and calculating residues	Ap	2,5
4	Understand the general form of Cauchy's theorem	U	4
5	Evaluate definite integrals.	An	5,6
6	Underrstands Harmonic functions	Ap	2,7

PSO – Programme Specific Outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO.No.
1.0	**Analytic functions as mappings.**	**20**	
1.1	Conformality: arcs and closed curves,	1	1
1.2	Conformality: analytic functions in regions	2	1
1.3	Conformality: conformal mapping	2	1
1.4	Conformality: length and area.	2	1
1.5	Linear transformations: linear group	2	1
1.6	Linear transformations: the cross ratio	2	1
1.7	Linear transformations: symmetry	2	1
1.8	Linear transformations: oriented circles	1	1
1.9	Linear transformations: family of circles.	2	1
1.10	Elementary conformal mappings: the use of level curves	1	1
1.11	Elementary conformal mappings: A survey of elementary mappings	1	1
1.12	Elementary conformal mappings:	2	1

	Elementary Riemann surfaces.		
2.0	**Complex Integration**	**20**	
2.1	Fundamental theorem: line integrals	3	2
2.2	Fundamental theorem: rectifiable arcs	2	2
2.3	Fundamental theorem: line integrals as functions of arcs	2	2
2.4	Fundamental theorem: , Cauchy's theorem for a rectangle	3	2
2.5	Fundamental theorem: Cauchy's theorem in a disk	2	2
2.6	Cauchy's integral formula: the index of a point with respect to a cloud curve	3	2
27	Cauchy's integral formula: the integral formula	2	2
2.7	Cauchy's integral formula: higher derivatives.	3	2
3.0	**Local properties of analytical functions**	**22**	
3.1	Local properties of analytical functions: removable singularities	1	3
3.2	Local properties of analytical functions: Taylor's theorem	2	3
3.3	Local properties of analytical functions: zeroes and poles	3	3
3.4	Local properties of analytical functions: the local mapping	3	3
3.5	Local properties of analytical functions: the maximum principle.	3	3
3.6	The general form of Cauchy's theorem: chains and cycles	1	4
3.7	The general form of Cauchy's theorem: simple connectivity	2	4
3.8	The general form of Cauchy's theorem: general statement of Cauchy's theorem	1	4
3.9	The general form of Cauchy's theorem: proof of Cauchy's theorem	2	4
3.10	The general form of Cauchy's theorem: locally exact differentiation	2	4
3.11	The general form of Cauchy's theorem: multiply connected regions.	2	4
4.0	**Calculus of Residues**	**12**	
4.1	Calculus of Residues: the residue theorem	3	5
4.2	Calculus of Residues: the argument principle	3	5
4.3	Calculus of Residues: evaluation of definite integrals.	6	5
5.0	**Harmonic functions**	**16**	
5.1	Harmonic functions: definition and basic properties	3	6
5.2	Harmonic functions:, the mean value property	3	6

5.3	Harmonic functions: Poisson’s formula,	3	6
5.4	Harmonic functions: Schwarz theorem.	3	6
5.5	Harmonic functions: the reflection principle.	3	6

Text Books for Enrichment

1. Chaudhary. B, The elements of Complex Analysis, Wiley Eastern.
2. Cartan. H (1973), Elementary theory of Analytic functions of one or several variable, Addison Wesley.
3. Conway .J.B, Functions of one Complex variable, Narosa publishing.
4. Lang. S, Complex Analysis, Springer.
5. H.A. Priestly, Introduction to Complex Analysis, Clarendon press, Oxford, 1990.

SEMESTER II

Course	Details				
Code	MT1922106				
Title	**Abstract Algebra**				
Degree	M Sc.				
Branch(s)	Mathematics				
Year/Semester	1/II				
Type	Core				
Credits	4	Hours/week	5	Total Hours	90

CO No.	*Expected Course Outcomes* *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Asses properties implied by the definitions of group and rings	U	2, 3
2	Use the various canonical type of groups (including cyclic groups and group of permutations) and canonical types of rings (including polynomial rings and modular rings)	Ap	3, 4
3	Analyze and demonstrate examples of subgroups, normal subgroup and quotient groups	An	4
4	Analyze and demonstrate examples of ideals and quotient rings.	An	2, 4
5	Use the concept of isomorphism homomorphism for groups and rings	Ap	3
6	Understand and apply fundamental theorems from the theory of Splitting fields, separable extensions and Perfect Fields including the Primitive Element Theorem	U	3
7	Understand the basic theory of Galois	U	3
8	Produce rigorous proofs of propositions arising in the context of abstract algebra	C	2

PSO – Programme Specific Outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO.No.
1.0	**Module 1**		1,2,3
1.1	Direct products and finitely generated Abelian groups	4	1,2,3
1.2	fundamental theorem (without proof)	4	1,2,3,8
1.3	Applications	4	1,2,3
1.4	Sylow's theorems (without proof)	4	1,2,3,8
1.5	Applications of sylow theory	4	1,2,3
2.0	**Module 2**		
2.1	Rings of polynomials,	4	2,4
2.2	Factorisation of polynomials over a field	4	2,4
2.3	Introduction to extension fields	4	2,4

2.4	Algebraic extensions	4	2,4
2.5	Geometric constructions	4	2,4
3.0	**Module 3**		
3.1	Finite fields.	4	5
3.2	The Existence of GF(p^n)	4	5
3.3	Automorphism of fields	4	5,8
3.4	Automorphisms and Fixed Fields	4	5
3.5	The isomorphism extension theorem (proof of the theorem excluded)	4	5,8
4.0	**Module 4**		
4.1	Splitting fields	5	6
4.2	separable extensions,	5	6
4.3	Perfect Fields	5	6
4.4	The Primitive Element Theorem	5	6,8
5.0	**Module 5**		
5.1	Normal Extensions	4	7
5.2	Galois theory	6	7,8

Text Books:

1. John B. Fraleigh, A First Course in Abstract Algebra, 7th edition, Pearson Education.

Module 1:
Part II – Section 11
Part VII Sections 36 & 37 (20 hours)

Module 2:
Part IV – Sections 22 & 23
Part VI – Section 29, 31 – 31.1 to 31.18 & 32 (20 hours)

Module 3:
Part VI – Section 33
Part X – Sections 48 & 49 - 49.1 to 49.5 (20 hours)

Module 4:
Part X – Sections 50, 51 & 53 -53.1 to 53.6 (20 hours)

Module 5:
Part X – Sections 53 -53.1 to 53.6 (10 hours)

Text Books for Reference

1. I.N. Herstein, Topics in Algebra, Wiley Eastern Ltd., New Delhi, 1975.
2. Hungerford, Algebra, Springer
3. M. Artin, Algebra, Prentice -Hall of India, 1991
4. N. Jacobson, Basic Algebra Vol. I, Hindustan Publishing Corporation
5. P.B. Bhattacharya, S.K. Jain, S.R. Nagapaul, Basic Abstract Algebra, 2ndedition, Cambridge University Press, Indian Edition, 1997.

Course	Details				
Code	MT1922107				
Title	**Advanced Topology**				
Degree	M Sc.				
Branch(s)	Mathematics				
Year/Semester	1/II				
Type	Core				
Credits	4	Hours/week	5	Total Hours	90

CO No.	*Expected Course Outcomes* *Upon completion of this course, the students will be able to:*	Cognitive Level	PSO No.
1	Understand the significance of the classic theorems characterising normality and apply them to various spaces	Ap	3,6
2	Define topology on the product of an arbitrary collection of topological spaces	U	2,3
3	Identify whether a given topological property is productive	Ap	3,4
4	Describe the concept of evaluation functions and explain embedding lemma	U	2,3
5	Apply the concept of nets to study various notions in topology	An	3,4,5
6	Define filter and apply it to prove Tychonoff' theorem.	Ap	2,3
7	Explain variations of compactness	R	3
8	Construct one-point compactification of given space.	An	2,5

PSO – Programme Specific Outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO.No.
1.0	**CHARACTERISATIONS OF NORMALITY** [Chapter 7 Section-3 and 4; Proof of 3.4, 4.4, and 4.5 excluded]	**20**	
1.1	Urysohn Characterisation of Normality	11	1
1.2	Tietze Characterisation of Normality	9	1
2.0	**PRODUCTS AND CO-PRODUCTS** [Chapter 8 Section 1, 2 & 3; proof of 1.6 &1.7 excluded.]	**15**	
2.1	Cartesian products of families of sets	4	2
2.2	Product Topology	4	2
2.3	Productive properties	5	2,3
2.4	Co-products	2	2,3
3.0	**EMBEDDING AND METRISATION** [Chapter 9 - Sec. 1, 2 & 3 of the text]	**15**	

3.1	Evaluation Functions	3	4
3.2	Embedding Lemma	4	4
3.3	Tychnoff Embedding	5	4
3.4	The Urysohn Metrisation Theorem	3	4
4.0	**NETS AND FILTERS** [Chapter 10 Sections 1, 2, 3 & 4 of the text]	**25**	
4.1	Definition and examples of nets	4	5
4.2	Convergence of Nets.	6	5
4.3	Properties of Nets	4	5
4.4	Filters and their Convergence	6	5,6
4.5	Ultra filters and Compactness	5	5,6
5.0	**VARIATIONS OF COMPACTNESS** [Chapter 11. Section 1 (Proof of theorem 1.4 & 1.12 excluded), Section 3, Section 4(from 4.1 to 4.7)]	**15**	
5.1	Variations of compactness	4	7
5.2	Local compactness	5	7
5.3	Compactification	6	7,8

Text Books:

K.D. Joshi, Introduction to General Topology, Wiley Eastern Ltd,1984.

Text Books for Reference

1. Munkres J.R, Topology-A First Course, Prentice Hall of India Pvt. Ltd., New Delhi, 2000.
2. J.L Kelley, General Topology, Van Nostrand, Reinhold Co., New York, 1995.
3. Stephen Willard, General Topology, Addison-Wesley.
4. Dugundji, Topology, Universal Book Stall, New Delhi.
5. George F Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill Book Company, 1963.

Course	Details				
Code	MT1922108				
Title	**Advanced Complex Analysis**				
Degree	M Sc.				
Branch(s)	Mathematics				
Year/Semester	1/II				
Type	Core				
Credits	4	Hours/week	5	Total Hours	90

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Understands power series	Ap	2,4
2	Understands partial fractions	E	3
3	Understands entire functions	Ap	1
4	Analyze the Riemann zeta function	An	3
5	Remember Normal families	U	2,3
6	Understands The Riemann mapping theorem	Ap	3,4
7	Analyze Elluiptic Functions	Ap	3,5
8	Remember Analytic continuation	R	3,4

PSO – Programme Specific Outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO.No.
1.0	**MODULE 1**	**25**	
1.1	Elementary theory of power series: sequences	2	1
1.2	Elementary theory of power series: series	1	1
1.3	Elementary theory of power series: uniform convergence	2	1
1.4	Elementary theory of power series: power series,	2	1
1.5	Elementary theory of power series: Abel's limit theorem.	2	1
1.6	Power series expansions: Weierstrass' theorem	2	1
1.7	Power series expansions: the Taylor's series	3	1
1.8	Power series expansions: Laurent's series	3	1
1.9	Partial fractions and factorisation: partial fractions	2	2
1.10	Partial fractions and factorisation: infinite products	2	2
1.11	Partial fractions and factorisation: canonical products.	2	2
1.12	Partial fractions and factorisation:	2	2

	the gamma functions.		
2.0	**MODULE 2**	**20**	
2.1	Entire functions: Jenson’s formula	3	3
2.2	Entire functions: Hadamard’s theorem (without proof)	2	3
2.3	the Riemann zeta function: the product development,	3	4
2.4	the Riemann zeta function: extension of □ □ to the whole plane	2	4
2.5	the Riemann zeta function the functional equation	3	4
2.6	the Riemann zeta functionthe zeroes of zeta function.	1	4
27	Normal families: Equi continuity	1	5
2.7	Normal families: normality and compactness	3	5
2.8	Normal families: Arzela’s theorem (without proof)	2	5
3.0	**MODULE 3**	**20**	
3.1	The Riemann mapping theorem: statement and proof	4	6
3.2	The Riemann mapping theorem: boundary behavior	1	6
3.3	The Riemann mapping theorem: use of reflection principle	1	6
3.4	The Riemann mapping theorem:analytic arcs.	1	6
3.5	Conformal mappings of polygons: the behavior of an angle	2	6
3.6	Conformal mappings of polygons the Schwarz- Christoffel formulaI (Statement only).	2	6
3.7	A closer look at harmonic functions: functions with mean value property, Harnack’s principle	4	4
3.8	The Dirichlet problem: sub harmonic functions	3	6
3.9	The Dirichlet problem: solution of Dirichlet problem (statement only)	2	6
4.0	**MODULE 4**	**12**	
4.1	Elliptic functions: simply periodic functions	1	7
4.2	Elliptic functions: representation of exponentials	1	57
4.3	Elliptic functions :the Fourier development, functions of finite order	2	7
4.4	Doubly periodic functions: The period module	2	7

4.5	Doubly periodic functions: unimodular transformations,	2	7
4.6	Doubly periodic functions: the canonical basis	2	7
4.7	Doubly periodic functions: general properties of elliptic functions..	2	7
5.0	**MODULE 5**	**13**	
5.1	The Weirstrass theory: the Weierstrass function	1	8
5.2	The Weirstrass theory: the functions □ □ (y) and □ □ (y),	1	8
5.3	The Weirstrass theory: the differential equation.	2	8
5.4	Analytic continuation: the Weierstrass theorem	1	8
5.5	Analytic continuation:, Germs and Sheaves	1	8
5.6	Analytic continuation: sections and Riemann surfaces,	1	8
5.7	Analytic continuation: analytic continuation along arcs	2	8
5.8	Analytic continuation: homotopic curves.	3	8

Text Books for Enrichment

1. Chaudhary. B, The elements of Complex Analysis, Wiley Eastern.
2. Cartan. H (1973), Elementary theory of Analytic functions of one or several variable, Addison Wesley.
3. Conway .J.B, Functions of one Complex variable, Narosa publishing.
4. Lang. S, Complex Analysis, Springer.
5. H.A. Priestly, Introduction to Complex Analysis, Clarendon press, Oxford, 1990.

Course	Details				
Code	MT1922109				
Title	**Partial Differential Equations**				
Degree	M Sc.				
Branch(s)	Mathematics				
Year/Semester	1/II				
Type	Core				
Credits	4	Hours/week	5	Total Hours	90

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to:*	Cognitive Level	PSO No.
1	Understand basic properties of standard partial differential equations.	U	1, 3
2	Apply a range of techniques to find solutions of standard partial differential equations.	Ap	4, 5
3	Solve linear and nonlinear partial differential equations of both first and second order.	Ap	5
4	Classify partial differential equations, apply analytical methods and physically interpret the solutions.	Ap	2, 7
5	Determine the existence, uniqueness and well-posedness of solution of partial differential equations.	An	2
6	Demonstrate capacity to model physical phenomena using partial differential equations.	An	1, 2, 3

PSO – Programme Specific Outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	Course Description	Hrs	CO.No.
1.0	**Partial Differential Equations**	**18**	
1.1	Methods of solutions of dx/p = dy/Q = dz/R	4	2
1.2	Orthogonal trajectories of a system of curves on a surface	3	1
1.3	Pfaffian differential forms and equations	3	2
1.4	Solution of Pfaffian differential equations in three variables	3	2
1.5	Origins of first order partial differential equation	3	1
1.6	Cauchy's problem for first order equation	2	1
2.0	**Linear and Non-linear Partial Differential Equations**	**16**	
2.1	Linear equations of first order	4	1
2.2	Integral surfaces passing through a given curve	3	1
2.3	Surfaces orthogonal to a given system of surfaces	4	1
2.4	Nonlinear partial differential equation of the first order	3	1
2.5	Cauchy's method of characteristics	2	1

3.0	**Solutions of First Order Equations**	**16**	
3.1	Compatible systems of first order equations	4	2, 3, 5
3.2	Charpits Method	3	2, 3
3.3	Special types of first order equations	3	4
3.4	Solutions satisfying given conditions	3	2, 3
3.5	Jacobi's method	3	2, 3
4.0	**Second Order Equations**	**20**	
4.1	The origin of second order equations	3	1
4.2	Linear partial differential equations with constant coefficients	7	1, 2, 3
4.3	Equations with variable coefficients	6	1, 2, 3
4.4	Characteristic curves of second order equations	4	1
5.0	**Non-Linear Equations of Second Order**	**20**	
5.1	The solution of linear Hyperbolic equations	3	3, 4
5.2	Separation of variables	5	4
5.3	Non linear equations of the second order	2	1, 3
5.4	Elementary solutions of Laplace equation	4	3, 6
5.5	Families of equipotential surfaces	3	4
5.6	Boundary value problems	3	3, 6

Text Books

1. **Ian Sneddon, Elements of partial differential equations, Mc Graw Hill Book Company**

(Sections 1.3 to 1.6 & 2.1 to 2.13
Section 3.1, 3.4, 3.5, 3.6, 3.8, 3.9 ,3.11
Section 4.2, 4.3,4.4 of the text)

Text Books for Reference

1 . Phoolan Prasad and Renuka Ravindran, Partial differential Equations, New Age International (p) Limited

2. K Sankara Rao, Introduction to Partial Differential Equations, Prentice-Hall of India

3. E.T Copson , Partial differential equations , S .Chand & Co

Course	Details				
Code	MT1922110				
Title	**Real Analysis**				
Degree	M Sc.				
Branch(s)	Mathematics				
Year/Semester	1/II				
Type	Core				
Credits	4	Hours/week	5	Total Hours	90

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to:*	Cognitive Level	PSO No.
1	Remember monotone functions and explore the properties	An	2,6
2	Understand and analyze bounded variation	An	2,3
3	Understand and analyze total variation	An	2,3
4	Analyze the properties of continous functions of bounded variation	An	2,3,4
5	Understand and analyze cuves, paths and arc length	An	5,7
6	Remember Riemann Integral and extend the idea to Riemann Stieltjes Integral	C	2,3,6
7	Remember Differentiation and understand the relation between differentiation and integration	U	2,3,6
8	Understand the concept of integration of vector valued functions	An	2,3,5
9	Remember convergence and understand and analyze uniform convergence	An	3,6
10	Analyze the realtion between uniform convergence and continuity	An	2,3,5
11	Analyze the realtion between uniform convergence and integration	An	2,3,5
12	Analyze the realtion between uniform convergence and differentiation	An	2,3,5
13	Understand Stone-Weirstrass theorem	U	1,2
14	Remember Power Series	R	5,6
15	Remember and explore logerithmic and exponential functions interms of power series	An	2,4,6
16	Remember and trigonometric functions interms of power series	An	2,4,6
17	Understand the algebraic completeness of complex field	U	1
18	Analyze Fourier Series	An	4,6

PSO – Programme Specific Outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	Course Description	Hrs	CO.No.
1.0	**Module 1**		
1.1	Introduction, properties of monotonic functions	3	1
1.2	functions of bounded variation	3	2
1.3	total variation	2	3
1.4	additive property of total variation	3	3
1.5	total variation on (a, x) as a functions of x, functions of bounded variation expressed as the difference of increasing functions	2	3
1.6	continuous functions of bounded variation	3	4
1.7	curves and paths	2	5
1.8	rectifiable path and arc length	3	5
1.9	additive and continuity properties of arc length	2	5
1.10	equivalence of paths	1	5
1.11	change of parameter	1	5
2.0	**Module 2**		
2.1	Definition and existence of the integral	5	6
2.2	properties of the integral	5	6
2.3	integration and differentiation	5	7
2.4	integration of vector valued functions	5	8
3.0	**Module 3**		
3.1	Discussion of main problem	2	9
3.2	uniform convergence	5	9
3.3	uniform convergence and continuity,	5	10
4.0	**Module 4**		
4.1	uniform convergence and integration	5	11
4.2	uniform convergence and differentiation	5	12
4.3	the Stone-Weierstrass theorem (without proof).	3	13
5.0	**Module 5**		
5.1	Power series	4	14
5.2	the exponential and logarithmic functions	4	15
5.3	the trigonometric functions	4	16
5.4	the algebraic completeness of complex field	4	17
5.5	Fourier series	4	18

Text 1: **Tom Apostol, Mathematical Analysis (second edition), Narosa Publishing House.**

Text 2: **Walter Rudin, Principles of Mathematical Analysis (Third edition), International Student Edition.**

Module 1:

((Chapter 6, Section: 6.1 - 6.12. of Text 1) (25 hours.)

Module 2:

(Chapter 6 - Section 6.1 to 6.25 of Text 2) (20 hours.)

Module 3:

(Chapter 7 Section. 7.7 to 7.1. of Text 2) (12 hours.)

Module 4:

(Chapter 7 Section. 7.1. to 7.18 of Text 2) (13 hours.)

Module 5:

(Chapter 8 - Section 8.1 to 8.16 of Text 2) (20 hours.)

References:-

1. Royden H.L, Real Analysis, 2nd edition, Macmillan, New York.
2. Bartle R.G, The Elements of Real Analysis, John Wiley and Sons.
3. S.C. Malik, Savitha Arora, Mathematical Analysis, New Age International Ltd.

Edwin Hewitt, Karl Stromberg, Real and Abstract Analysis, Springer International, 1978

SEMESTER III

Course	Details				
Code	MT1923111				
Title	**Multivariate Calculus And Integral Transforms**				
Degree	M Sc.				
Branch(s)	Mathematics				
Year/Semester	2/III				
Type	Core				
Credits	4	Hours/week	5	Total Hours	90

CO No.	*Expected Course Outcomes* *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Understand Weirstrass theorem	U	3
2	Evaluate Other forms of Fourier series	Ap	2,7
3	Understand The Fourier integral Theorem	U	3
4	Understands convolutions	U	2
5	Understand Multivariable differential calculus	An	4,5
6	Evaluate extremum problems	Ap	4,5
7	Evaluate Integration of Differential Forms	U	4,6

PSO – Programme Specific Outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	Course Description	Hrs	CO.No.
1.0	**Module 1**	**15**	
1.1	The Weirstrass theorem	2	1
1.2	Other forms of Fourier series	2	2
1.3	The Fourier integral Theorem	3	3
1.4	The exponential form of the Fourier integral theorem	2	3
1.5	Integral Transforms and convolutions	3	4
1.6	The convolution theorem for Fourier transforms	3	4
2.0	**Module 2**	**15**	
2.1	The directional derivative	1	5
2.2	Directional derivatives and continuity	1	5
2.3	The total Derivative	1	5
2.4	The total derivative expressed in terms of	3	5

	partial derivatives		
2.5	An Application Of Complex- Valued Functions	2	5
2.6	The matrix of a linear function	2	5
27	The Jacobian Matrix	2	5
2.7	The chain rule	2	5
2.8	Matrix form of the chain rule	1	5
3.0	**Module 3**	**15**	
3.1	Implicit functions and extremum problems	1	6
3.2	The mean value theorem for differentiable functions	1	6
3.3	A sufficient condition for differentiability	2	6
3.4	A sufficient condition for equality of mixed partial derivatives	4	6
4.0	**Module 4**	**20**	
4.1	Functions with non-zero Jacobian determinant	3	6
4.2	The inverse function theorem (without proof)	3	6
4.3	The Implicit function theorem (without proof)	3	6
4.4	Extrema of real- valued functions of One variable	3	6
4.5	Extrema of real- valued functions of several variables	3	6
5.0	**Module 5**	**25**	
5.1	Integration	1	7
5.2	Primitive mappings	1	7
5.3	Partitions of unity	1	7
5.4	Change of variables	2	7
5.5	Differential forms	1	7
5.6	Stokes theorem (without proof)	2	7

Text Books for Reference

1. Text 1: Tom APOSTOL, Mathematical Analysis, Second edition, Narosa Publishing House.
2. Text 2: WALTER RUDIN, Principles of Mathematical Analysis, Third edition – International Student Edition.

Module I	(Chapter 11 Sections 11.15 to 11.21 of Text 1)
Module II	(Chapter 12 Sections. 12.1 to 12.10 of Text 1)
Module III	(Chapter 12 Sections-. 12.11 to 12.13. of Text 1)
Module IV	(Chapter 13 Sections-. 13.1 to 13.6 of Text 1)
Module V	(Chapter 10 Sections. 10.1 to 10.25, 10.33 of Text 2)

Text Books for Enrichment

1. Hardy G.H and Wright E.M , Introduction to the Theory of numbers, Oxford, 1981
2. Leveque W.J, Topics in Number Theory, Addison Wesley, 1961.
3. J.P Serre, A Course in Arithmetic, GTM Vol. 7, Springer-Verlag, 1973

Course	Details				
Code	MT1923112				
Title	**Functional Analysis**				
Degree	M Sc.				
Branch(s)	Mathematics				
Year/Semester	2/III				
Type	Core				
Credits	4	Hours/week	4	Total Hours	72

CO No.	*Expected Course Outcomes* *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Realize how functional analysis uses and unifies ideas from linear algebra, the theory of metrics	An	2, 3
2	Understand and apply ideas from the theory of Hilbert spaces to other areas, including Fourier series	Ap	2
3	Understand the basic thoery of Bounded linear operators	U	3
4	Recognize the worth of Zorn's lemma.	An	4
5	Understand and apply fundamental theorems from the theory of normed and Banach spaces, including the Hahn-Banach theorem, Uniform boundedness principle.	Ap	4, 5

PSO – Programme Specific Outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	Course Description	Hrs	CO.No.
1.0	**Module 1. Fundamentals of Normed space.**		
1.1	Vector Space	2	1
1.2	Normed Space	3	1
1.3	Banach Space	2	1
1.4	Further Properties of Normed Spaces	2	1
1.5	Finite Dimensional Normed Spaces	2	1
1.6	Subspaces	2	1
1.7	Compactness and Finite Dimension	2	1
2.0	**Module 2. Bounded operators on Normed space.**		
2.1	Linear Operators	3	3
2.2	Bounded and Continuous Linear Operators	3	3
2.3	Linear Operators and Functionals On Finite Dimensional Spaces	3	3
2.4	Normed Spaces Of Operators	3	3
2.5	Dual Space	3	3

3.0	**Module 3. Inner Product Space**		
3.1	Inner product space	3	2
3.2	Hilbert space	3	2
3.3	Further Properties of Inner Product Space	2	2
3.4	Orthogonal Complements and Direct Sums	3	2
3.5	Orthonormal Sets and Sequences	2	2
3.6	Series Related to Orthonormal Sequences and Sets	2	2
4.0	**Module 4. Bounded operators on Hilbert space.**		
4.1	Total orthonormal sets and sequences	4	2
4.2	Representation of functionals on Hilbert spaces	4	2
4.3	Hilbert adjoint operators	4	2
4.4	Self adjoint	4	2
4.5	Unitary and Normal Operators	4	2
5.0	**Module 5. Fundamental theorems for Normed and Banach space**		
5.1	Zorn's lemma	4	4
5.2	Hahn- Banach theorem	4	5
5.3	Hahn- Banach theorem for complex vector spaces and normed spaces	3	5
5.4	Adjoint Operators	3	5
5.5	Reflexive Spaces	4	5
5.6	Category Theorem (Statement Only),	3	5
5.7	Uniform Boundedness Theorem	4	5

Text Books:

1. **Erwin Kreyszig, Introductory Functional Analysis with applications, John Wiley and sons, New York**

   Module 1:
   Chapter 2 - Sections 2.1 – 2.5 of the text (15 hours)

   Module 2:
   Chapter 2 - Section 2.6 to 2.10 of the text (15 hours)
   Module 3:
   Chapter 3 - Sections 3.1 to 3.5 of the text (15 hours)
   Module 4:
   Chapter 3 - Sections 3.6,3.8 to 3.10 (20 hours)
   Module 5:
   Chapter 4 – Sections 4.1 to 4.3, 4.5 to 4.7 of the text (25 hours)
   (category theorem - Statement only)

Text Books for Reference

1. Simmons, G.F, Introduction to Topology and Modern Analysis, McGraw –Hill, New York 1963.
2. Siddiqi, A.H, Functional Analysis with Applications, Tata McGraw –Hill, New Delhi : 1989
3. Somasundaram. D, Functional Analysis, S.Viswanathan Pvt. Ltd, Madras, 1994
4. Vasistha, A.R and Sharma I.N, Functional analysis, Krishnan Prakasan Media (P) Ltd, Meerut: 1995-96
5. M. Thamban Nair, Functional Analysis, A First Course, Prentice – Hall of India Pvt. Ltd, . 2008
6. Walter Rudin, Functional Analysis, TMH Edition, 1974.

Course	Details				
Code	MT1923113				
Title	**Differential Geometry**				
Degree	M Sc.				
Branch(s)	Mathematics				
Year/Semester	2/III				
Type	Core				
Credits	4	Hours/week	5	Total Hours	90

CO No.	*Expected Course Outcomes* *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Introduce graphs, level sets, vector fields, surfaces and orientation	U	3
2	Understand and analyze Gauss Map	An	2,7
3	Understand and Aplly Geodesics	Ap	4,7
4	Understand and AnalyzeParallel Transport	An	2,7
5	Understand and evaluate Weingarten Map	E	3,5
6	Understand and evalutae curvature of plane curve	E	5,7
7	Undersatand and evaluate and anlyze arc lenght and line integrals	E	5,6
8	Analyze the curvature of sufaces	An	1,2

PSO – Programme Specific Outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	Course Description	Hrs	CO.No.
1.0	**Module 1**		
1.01	Graphs and Level Sets	3	1
1.02	Vector Fields	3	1
1.03	The Tangent Space	3	1
1.04	Surfaces	3	1
1.05	Vector Fields on Surfaces and Orientation	3	1
2.0	**Module 2**		
2.1	Gauss Map	7	2
2.2	Geodesics	6	3
2.3	Parallel Transport	7	4
3.0	**Module 3**		
3.1	Wiengarten Map	10	5
3.2	Curvature of Plane Curve	5	6
3.3	Arc Lenghth and Line Integrals	10	7

4.0	**Module 4**		
4.1	Curvature of Surfaces	15	8
5.0	**Module 5**		
5.1	Parametrized Surfaces	6	8
5.2	Local Equivalence of Surfaces and Parametrized Surfaces	9	8

Text Book:
John A. Thorpe, Elementary Topics in Differential Geometry

Module 1:
Chapter 1 – 5 (15 hours.)
Module 2:
Chapter 6,7 and 8 (20 hours.)
Module 3
Chapter 9,10, and 11 (25 hours.)
Module 4:
Chapter 12 (15 hours.)
Module 5:
Chapter 14 and 15 (15 hours.)

Books for Reference

1. 1. Serge Lang, Differential Manifolds
2. I.M. Siger, J.A Thorpe, Lecture notes on Elementary topology and Geometry, Springer – Verlag, 1967.
3. S. Sternberg, Lectures on Differential Geometry, Prentice-Hall, 1964.
4. M. DoCarmo, Differential Geometry of curves and surfaces.
5. Goursat, Mathematical Analysis, Vol – 1(last two chapters)

Course	Details				
Code	MT1923114				
Title	**Number Theory And Cryptography**				
Degree	M Sc.				
Branch(s)	Mathematics				
Year/Semester	2/III				
Type	Core				
Credits	4	Hours/week	5	Total Hours	90

CO No.	*Expected Course Outcomes* *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Convert numbers into different bases	Ap	5
2	Explain the significance of number of bit operations required in computations	An	1,2
3	Explain the big O notation	U	3,4
4	Evaluate the time required for various computations	Ap	1,4,5
5	Find time estimate for Euclidean algorithm and use it to solve various problems.	Ap	2,3,4,5
6	Explain different properties of congruences	U	2,3
7	Understand quadratic reciprocity law and apply it to determine quadratic residues.	Ap	2,3,5
8	Explain pros and cons of public key cryptography	An	2,3
9	Evaluate discrete log using Silver Pohlig Hellman algorithm	Ap	2,5
10	Explain the concept of different kinds of pseudoprimes	U	2,3
11	Factorise numbers using various algorithms	Ap	2,3,5

PSO – Programme Specific Outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	Course Description	Hrs	CO.No.
1.0	**TIME ESTIMATES** [Chapter 1 Section – 1]	**15**	
1.1	Numbers in Different Bases	4	1
1.2	Number of digits in different bases	3	1,2
1.3	Bit operations	2	2
1.4	The Big – O notation	1	3
1.5	Time Required for various computations	5	3,4
2.0	**DIVISIBILITY AND CONGRUENCES** [Chapter 1 - Sections 2,3 and 4 of the text]	**15**	
2.1	Divisibility	1	5
2.2	The Euclidean algorithm	3	5

2.3	Congruences- Basic Properties	4	6
2.4	Modular Exponentiation by Repeated Squaring Method	3	6
2.5	Some Applications to Factoring	4	6
3.0	**FINITE FIELDS AND QUADRATIC RESIDUES** [Chapter 2- SECTIONS 1,2]	**20**	
3.1	Finite fields	5	7
3.2	Quadratic residues	3	7
3.3	Legendre Symbol and its properties	4	7
3.4	Jacobi Symbol	3	7
3.5	Quadratic Reciprocity Law	5	7
4.0	**PUBLIC KEY** [Chapter 4 - Sections 1, 2 & 3 of the text]	15	
4.1	Symmetric Key Cryptography	2	8
4.2	The idea of public key cryptography	3	8
4.3	**RSA**	2	8
4.4	Discrete log	3	8,9
4.5	Silver- Pohlig- Hellman algorithm	5	8,9
5.0	**PRIMALITY AND FACTORING** [Chapter – 5 Sections 1,2 ,3 & 5]	**25**	
5.1	Pseudo primes	5	10
5.2	The rho method	4	11
5.3	Fermat factorization	6	11
5.4	Factor bases	5	11
5.5	The quadratic sieve method.	5	11

Text Books:

Neal Koblitz, A Course in Number Theory and Cryptography, 2nd edition, Springer Verlag.

Text Books for Reference

1. **Niven, H.S. Zuckerman and H.L. Montgomery**, *An introduction to the theory of numbers*, John Wiley, 5th Edition.
2. **Ireland and Rosen**, *A Classical Introduction to Modern Number Theory*. Springer, 2nd edition, 1990.
3. **David Burton**, *Elementary Number Theory and its applications,* Mc Graw-Hill Education (India) Pvt. Ltd, 2006.
4. **Alfred J. Menezes, Paul C. van Oorschot and Scott A. Vanstone**, *Handbook of Applied Cryptography*, CRC Press, 1996
5. **Douglas R. Stinson,** *Cryptography Theory and Practice*, Chapman & Hall, 2nd edition
6. **Victor Shoup**, A computation Introduction to Number Theory and Algebra, , Cambridge University Press, 2005
7. **William Stallings**, *Cryptography and Network Security Principles and Practice,*Third edition, Prentice-hall, India.

Course	Details				
Code	MT1923115				
Title	**Optimization Techniques**				
Degree	M Sc.				
Branch(s)	Mathematics				
Year/Semester	2/III				
Type	Core				
Credits	4	Hours/week	5	Total Hours	90

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Understand the basic of Integer programming	U	7
2	Apply the concepts to solve problems	Ap	4
3	Analyse mathematical problems algorithmically	An	1
4	Enhance computational efficiency	Ap	5
5	Introduce the fundamentals of sensitivity analysis	An	2
6	Evaluate optimal measures related to flow and potentials in networks	U	3,5
7	Understand the basics of game theory	Ap	1
8	Using the basic concepts of Non linear programming for optimization	Ap	7,1

PSO – Programme Specific Outcome; CO-Course Outcome; Cognitive Level R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	Course Description	Hrs	CO.No.
1.0	**INTEGER PROGRAMMING**	**20**	
1.1	I.L.P in two dimensional space	3	1,2,4
1.2	General I.L.P. and M.I.L.P problems	4	1,2
1.3	Cutting planes	3	1,2
1.4	Remarks on cutting plane methods	4	1,2
1.5	Branch and bound method- examples	4	1,2,4
1.6	General description – the 0 – 1 variable.	2	1,2
2.0	**SENSITIVITY ANALYSIS**	**10**	
2.1	Introduction	1	2
2.2	Changes in b_i – changes in c_j – Changes in a_{ij}	2	2,3
2.3	Introduction of new variables	1	3
2.4	Introduction of new constraints	2	2,3
2.5	Deletion of variables	1	2,3
2.6	Deletion of constraints	1	2,3
2.7	Goal programming.	2	2,3
3.0	**FLOW AND POTENTIALS NETWORKS**	**15**	
3.1	Graphs- definitions and notation	1	5,6
3.2	Minimum path problem	1	5,6

3.3	Spanning tree of minimum length	2	5,6
3.4	Problem of minimum potential difference	3	5,6
3.5	Scheduling of sequential activities	2	5,6
3.6	Maximum flow problem	2	5,6
3.7	Duality in the maximum flow problem	2	5,6
3.8	Generalized problem of maximum flow	2	5,6
4.0	**THEORY OF GAMES**	**20**	
4.1	Matrix (or rectangular) games	2	2,4,7
4.2	Problem of games	3	2,4,7
4.3	Minimax theorem	2	7
4.4	Saddle point	1	7
4.5	Strategies and pay off	2	7
4.6	Theorems Of Matrix Games	3	7
4.7	Graphical solution	3	2,7
4.8	Notion of dominance	2	7
4.9	Rectangular game as an L.P. problem.	2	7
5.0	**NON- LINEAR PROGRAMMING**	**25**	
5.1	Basic concepts	2	3
5.2	Taylor's series expansion	2	3,8
5.3	Fibonacci Search	2	3,8
5.4	Golden section search	2	8
5.5	Hooke and Jeeves search algorithm	2	8
5.6	Gradient projection search	3	8
5.7	Lagrange multipliers – equality constraint optimization	3	4,8
5.8	Constrained derivatives	3	8
5.9	Project gradient methods with equality constraints	2	8
5.10	Non-linear optimization: Kuhn-Tucker conditions	2	4,8
5.11	Complimentary Pivot algorithms	2	4,8

Text Books

1. K.V. Mital and C. Mohan, Optimization Methods in Operation Research and Systems Analysis, 3rd edition.
2. Ravindran, Philips and Solberg. Operations Research Principle and Practice, 2nd edition, John Wiley and Sons
   (Chapter 6; sections: 6.1 – 6.10 of text – 1)
   (Chapter – 5 & 7 Sections 5.1 to 5.9 of text -1)
   (chapter 7 sections 7.1 to 7.9, 7.15 of text - 1)
   (Chapter 12; Sections: 12.1 – 12.9 of text – 1)
   Chapter 8; Sections: 8.1 – 8.14 of text – 2)

Text Books for Enrichment

1. S.S. Rao, Optimization Theory and Applications, 2nd edition, New Age International Pvt.
2. J.K. Sharma, Operations Research: Theory and Applications, Third edition, Macmillan India Ltd.
3. Hamdy A. Thaha, Operations Research – An Introduction, 6th edition, Prentice Hall of India Pvt. Ltd.

SEMESTER IV

Course	Details				
Code	MT1924116				
Title	**Spectral Theory**				
Degree	M Sc.				
Branch(s)	Mathematics				
Year/Semester	2/IV				
Type	Core				
Credits	4	Hours/week	4	Total Hours	72

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to:*	Cognitive Level	PSO No.
1	Understand fundamental theorems of normed space and its application, including the open mapping theorem, closed graph theorem	An	3
2	Understand fundamentals of spectral theory of operators	U	1, 3
3	Identify self-adjoint transformations and apply the spectral theorem and orthogonal decomposition of inner product spaces.	Ap	2, 4
4	Demonstrate capacity for mathematical reasoning through analyzing, proving and explaining concepts from spectral theory.	E	4
5	Understand and apply fundamental theorems from the theory of Compact linear operators and their spectrum.	Ap	4, 5
6	Understand the basic thoery of Banach algebras and unbounded operator theory	U	3
7	Learn to model different types of problems and select the suitable packages to solve the given problems.	E	4, 5

PSO – Programme Specific Outcome; CO-Course Outcome; Cognitive Level R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	Course Description	Hrs	CO.No.
1.0	**Module 1: Fundametal Theorems On Banach Space**	**25**	
1.1	Strong and weak convergence	4	1
1.2	Convergence of sequence of operators and functionals	4	1
1.3	Open mapping theorem	5	1
1.4	Closed linear operators	4	1

1.5	Closed graph theorem	4	1
1.6	Banach fixed point theorem	4	1,7
2.0	**Module 2:** **Spectral Theory of Linear Operators**.	**18**	
2.1	Spectral theory in finite dimensional normed space	4	2,4
2.2	Basic concepts	3	2,4
2.3	Spectral properties of bounded linear operators	4	2,4
2.4	Further properties of resolvant and spectrum	4	2,4
2.5	Use of complex analysis in spectral theory	3	2,7
3.0	**Module 3** : **Compact Linear Operators and Their Spectrum**	**15**	
3.1	Compact linear operators on normed spaces	4	5
3.2	Further properties of compact linear operators	4	5
3.3	Spectral properties of compact linear operators on normed spaces	4	5,4
3.4	Further spectral properties of compact linear operators	3	5
4.0	**Module 4:** **Spectral Theory of Bounded Self – Adjoint Operator**	**20**	
4.1	Spectral properties of bounded self adjoint linear operators	4	3,4
4.2	Further spectral properties of bounded self adjoint linear operators	4	3
4.3	Positive operators	4	3
4.4	Projection operators	4	3
4.5	Further properties of projections	4	3,7
5.0	**Module 5:** **Banach Algebra, Unbounded Operator Theory**	**12**	
5.1	Banach algebras	3	6,7
5.2	Further properties of Banach algebras	2	6
5.3	Unbounded linear operators and their Hilbert adjoint operators	2	6
5.4	Hilbert adjoint operators	3	6
5.5	Symmetric and self adjoint linear operators	2	6

Text Books:

2. **Erwin Kreyszig, Introductory Functional Analysis with applications, John Wiley and sons, New York**

   Module 1:
   Chapter 4 - Sections 4.8, 4.9, 4.12 & 4.13 - Chapter 5 – Section 5.1 of the text (25 hours)
   Module 2:

Chapter 7 - Sections 7.1 to 7.5 of the text (18 hours)

Module 3:

Chapter 8 - Sections 8.1 to 8.4 of the text (15 hours)

Module 4:

Chapter 9 - Sections 9.1, 9.2, 9.3, 9.5, 9.6 of the text (20 hours)

Module 5:

Chapter 7 - Sections 7.6 & 7.7 - Chapter 10 - Sections 10.1 & 10.2 of the text

(12 hours)

Text Books for Reference

1. Simmons, G.F, Introduction to Topology and Modern Analysis, McGraw –Hill, New York, 1963.
2. Siddiqi, A.H, Functional Analysis with Applications, Tata McGraw –Hill, New Delhi, 1989
3. Somasundaram. D, Functional Analysis, S.Viswanathan Pvt Ltd, Madras,1994
4. Vasistha, A.R and Sharma I.N, Functional analysis, Krishnan Prakasan Media (P) Ltd, Meerut: 1995-96
5. M. Thamban Nair, Functional Analysis, A First Course, Prentice – Hall of India Pvt. Ltd, 2008
6. Walter Rudin, Functional Analysis, TMH Edition, 1974.

Course	Details				
Code	MT1924301				
Title	**Analytic Number Theory**				
Degree	M Sc.				
Branch(s)	Mathematics				
Year/Semester	2/IV				
Type	Elective				
Credits	3	Hours/week	5	Total Hours	90

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to:*	Cognitive Level	PSO No.
1	Identify Arithmetic Functions and Dirichlet Multiplication	U	2,3
2	Understand Formal power series.	Ap	3,4
3	Understand Euler's summation formula	Ap	2
4	Evaluate asymptotic formulas	E	3,4
5	Understand Some Elementary Theorems on the Distribution of Prime Numbers.	An	4,6
6	Understands Congruences	Ap	3,6
7	Understands Primitive roots and partitions	U	6

PSO – Programme Specific Outcome; CO-Course Outcome; Cognitive Level R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	Course Description	Hrs	CO.No.
1.0	**Arithmetic Functions and Dirichlet Multiplication**	**15**	
1.1	The Mobius function	1	1
1.2	The Euler totient Function	1	1
1.3	A relation connecting Mobius function and the Euler totient Function	1	1
1.4	The Dirichlet product of Arithmetical functions	1	1
1.5	Dirichlet inverses and Mobius inversion formula	2	1
1.6	The Mangoldt function	1	1
1.7	Multiplicative functions and Dirichlet multiplication	1	1
1.8	The inverse of completely multiplicative functions	1	1
1.9	The Liovillie's function	1	1
1.10	The Divisor function	1	1
1.11	Generalized convolutions	1	1
1.12	Formal power series.	1	2

1.13	The Bell Series of an arithmetical function	1	2
1.14	Bell series and Dirichlet multiplication	1	2
2.0	**Euler's summation formula**	**15**	
2.1	The big oh notation	1	2
2.2	Asymptotic equality of Functions	1	3
2.3	Euler's summation formula	1	3
2.4	Some elementary asymptotic formulas	2	4
2.5	The Average order of d(n)	2	4
2.6	The average order of the divisor function	2	4
27	Average order of euler totient Function	1	4
2.7	An application of distribution of lattice points visible from the origin	2	4
2.8	Average order of mobius function and mangoldt function	1	4
2.9	The partial sums of a Dirichlet product	1	4
2.10	Application to Mobius function and Mangoldt function	1	4
3.0	**Some Elementary Theorems on the Distribution of Prime Numbers**	**15**	
3.1	Chebyshev's functions	1	5
3.2	Relation connecting Chebyshev's functions	1	5
3.3	Some equivalent forms of prime number theorem	2	5
3.4	Inequalities of $\pi(n)$ and P_n.	4	5
3.5	Shapiro's Tauberian theorem .	3	5
3.6	Applications of Shapiro's theorem	2	5
3.7	AnAsymptotic formula for the partial sum $\sum_{p\leq x}\frac{1}{p}$	2	5
4.0	**Congruences**	**30**	
4.1	Definition and basic properties of congruences	3	6
4.2	Residue classes and complete residue Systems	3	6
4.3	Liner congruences	3	6
4.4	Reduced residue systems and Euler – Fermat theorem	3	6
4.5	Polynomial congruences modulo p	3	6
4.6	Lagrange's theorem	3	6
4.7	Applications of Lagrange's Theorem	3	6
4.8	Simultaneous linear congruences	2	6
4.9	The Chinese reminder theorem	2	6
4.10	Applications of Chinese reminder theorem	3	6
4.11	Polynomial congruences with prime power Moduli	2	6
5.0	**Primitive roots and partitions**	**15**	
5.1	The exponent of a number mod m.	1	7
5.2	Primitive roots	1	7
5.3	Primitive roots and reduced Systems	1	7
5.4	The non existence of Primitive roots mod 2^n □for	2	7

	n□ □ 3.		
5.5	The existence of Primitive roots mod p for odd primes p	1	7
5.6	Primitive roots and quadratic residues	2	7
5.7	Partitions – introduction	1	7
5.8	Geometric representation of partitions	2	7
5.9	Generating functions For partitions	2	7
5.10	Euler’s pentagonal-number theorem	2	7

Text Books for Reference

1. Tom M Apostol, Introduction to Analytic Number Theory, Springer InternationalStudent Edition, Narosa Publishing

Module I	Chapter 2 sections 2.1 to 2.17
Module II	Chapter 3 sections 3.1 to 3.11
Module III	Chapter 4 sections 4.1 to 4.8
Module IV	Chapter 5 sections 5.1 to 5.9.
Module V	Chapter 10 sections 10.1 to 10.5 & Chapter 14 sections 14.1 to 14.4

Text Books for Enrichment

1. Hardy G.H and Wright E.M , Introduction to the Theory of numbers, Oxford, 1981
2. Leveque W.J, Topics in Number Theory, Addison Wesley, 1961.
3. J.P Serre, A Course in Arithmetic, GTM Vol. 7, Springer-Verlag, 19

Course	Details				
Code	MT1924302				
Title	**Combinatorics**				
Degree	M Sc.				
Branch(s)	Mathematics				
Year/Semester	2/IV				
Type	Elective				
Credits	3	Hours/week	5	Total Hours	90

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to:*	Cognitive Level	PSO No.
1	Familiarize with fundamental combinatorial structures that appear in different branches of mathematics and computer science.	U	1,6,7
2	Understand and apply different counting principles in various situations	Ap	2,5,6
3	Analyse different properties of permutations and combinations	An	2,3,4
4	Use combinatorial structures to represent mathematical and applied problems.	An	2,3,4,5,6
5	Understand the properties of Stirling numbers of first and second kinds.	Ap	2,3,7
6	Apply graph theory to learn properties of Ramsey numbers	Ap	2,3,6,7
7	Apply the properties of derangements to various problems	Ap	2,3,6,7
8	Use the concepts of generating functions and recurrence relations to combinatorial problems.	Ap	2,3,4,5

PSO – Programme Specific Outcome; CO-Course Outcome; Cognitive Level R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	Course Description	Hrs	CO.No.
1.0	**PERMUTATIONS AND COMBINATIONS** [Chapter 1 Sections(1.1-1.4)]	**15**	
1.1	The Addition Principle	2	1,2,3,4
1.2	The Multiplication Principle	3	1,2,3,4
1.3	Permutations	4	3,4
1.4	Circular permutations	3	3,4
1.5	Combinations	3	3,4

2.0	**INJECTION AND BIJECTION PRINCIPLES** [Chapter 1 Sections(1.5-1.7)]	**15**	
2.1	The Injection Principle	3	1,2
2.2	The Bijection Principle	3	1,2
2.3	Arrangements and selection with repetitions	4	1,4
2.4	Distribution problems	5	1,4
3.0	**THE PIGEONHOLE PRINCIPLE AND RAMSEY NUMBERS** [Chapter 3]	**15**	
3.1	Introduction	2	1,2,4
3.2	The pigeonhole principle	4	1,2,4
3.3	Applications of Pigeonhole principle-More examples	4	1,2,4
3.4	Ramsey type problems and Ramsey numbers	3	1,2,4,6
3.5	Bounds for Ramsey numbers	2	1,2,4,6
4.0	**PRINCIPLE OF INCLUSION AND EXCLUSION** [Chapter 4 (4.1-4.7)]	**20**	
4.1	The Principle of Inclusion and Exclusion	3	1,2,4
4.2	Generalisation	2	1,2,4
4.3	Integer solutions and shortest routes	4	1,2,4
4.4	Surjective mappings	2	1,2,4,5
4.5	Sterling numbers of the second kind	3	1,2,4,5
4.6	Derangements and a generalization	4	1,2,7
4.7	The Sieve of Eratosathenes	4	1,2,7
4.8	Euler j -function	3	1,2,3,4
5.0	**GENERATING FUNCTIONS** [Chapters – 5, 6(6.1-6.5)]	**25**	
5.1	Ordinary generating functions and Some modelling problems	5	1,4,8
5.2	Partitions of integer	4	1,4,8
5.3	Exponential generating functions	3	1,4,8
5.4	Recurrence Relations- introduction and examples	4	1,4,8

Text Books:

Chen Chuan -Chong, Koh Khee Meng, Principles and Techniques in Combinatorics, World Scientific,1999**.**

Text Books for Reference

1. V Krishnamoorthy, Combinatorics theory and applications, E. Hoewood, 1986
2. Hall,Jr, Combinatorial Theory, Wiley- Interscinice, 1998.
3. Brualdi, R A, Introductory Combinatorics, Prentice Hall,1992

Course	Details				
Code	MT1924303				
Title	**Operations Research**				
Degree	M Sc.				
Branch(s)	Mathematics				
Year/Semester	2/IV				
Type	Elective				
Credits	3	Hours/week	5	Total Hours	90

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Understand the concepts in the mathematical modelling	U	1,2
2	Evaluate EOQ in different inventory models	Ap	1,2,7
3	Distinguish between various models in queues	Ap	3
4	Evaluate various measures of performance in queueing models	E	3,5
5	Apply the techniques of D.P to solve problems	Ap	3,4
6	To find optimal sequences in various sequencing problems	Ap	6,7
7	Find better approximations of results using simulations	Ap	5,7

PSO – Programme Specific Outcome; CO-Course Outcome; Cognitive Level R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	Course Description	Hrs	CO.No.
1.0	**Inventory Models**	**20**	
1.1	Inventory models - Introduction	2	1,2
1.2	Variables in an inventory problem	2	1,2
1.3	Objectives of inventory control	1	1,2
1.4	The classical E.O.Q. without shortages	2	2
1.5	The classical E.O.Q. with shortages	2	2
1.6	The Production Lot size (P.L.S) models	3	2
1.7	Nonzero Lead time	2	2
1.8	The Newsboy Problem (a single period model)	3	2
1.9	Lot size reorder point model- Variable lead times	2	2
1.10	The importance of selecting the right model	1	2
2.0	**Queueing Systems**	**25**	
2.1	Why study queues?	1	1
2.2	Elements of a queueing model	1	3
2.3	Role of exponential distribution (Derivation of	2	3

	exponential distribution; forgetfulness property)		
2.4	Pure Birth and Death models	2	3
2.5	Relationship between the exponential and Poisson distributions	3	3
2.6	Generalized Queueing Models	2	3,4
2.7	Kendall notation	2	3
2.8	Poisson Queueing Models	1	3,4
2.9	Single server models and multiple server models	2	3,4
2.10	Machine servicing models	3	3,4
2.11	M/M/R) : (GD/K/K) Model	2	3,4
2.12	(M/G/1) : (GD/) model	2	3,4
2.13	Pollaczek- Khintchine (P - K) formula.	2	3
3.0	**Dynamic Programming**	**20**	
3.1	Introduction	1	5
3.2	Minimum path problem	2	5
3.3	Single additive constraint, additively separable return	2	5
3.4	Single multiplicative constraints, additively separable return	2	5
3.5	Single additiveconstraint, multiplicatively separable return	2	5
3.6	Computational economy in DP	1	5
3.7	Serial multistage models	2	5
53.8	Examples of failure	1	5
3.9	Decomposition	2	5
3.10	backward and forward recursions	2	5
3.11	Systems with more than one constraint	2	5
3.12	Applications of D.P to continuous systems.	1	5
4.0	**Network Sequencing**	**15**	
4.1	Problem of sequencing	2	6
4.2	Basic assumptions	2	6
4.3	Processing n jobs through two machines	3	6
4.4	Optimum Sequence (Johnson Bellman) Algorithm	2	6
4.5	Processing n jobs through k machines	2	6
4.6	Processing of two jobs through k machines	2	6
4.7	Maintenance crew scheduling	2	6
5.0	**Simulation**	**10**	
5.1	Simulation	1	7
5.2	Generation of random variables	2	7
5.3	Monte Carlo simulation	3	7
5.4	Sampling from probability distributions-1. Inverse	3	7

	method, 2. Convolution method (&Box- Muller method), 3. Acceptance-Rejection method		
5.5	Generic definition of events.	1	7

Text Books

1. Ravindran. A, Don T Philips and James J Solberg., Operations Research Principle and Practice, 2nd edition, John Wiley and Sons.
2. Hamdy A. Thaha, Operations Research – An Introduction, 6th edition, Prentice Hall of India Pvt. Ltd.
3. K.V. Mital and C. Mohan, Optimization Methods in Operation Research and Systems Analysis, 3rd edition, New Age International Pvt. Ltd.
4. Man Mohan, P.K. Gupta and Kanti Swarup, Operations Research, Sultan Chand and Sons.
   (Chapter 8; Sections: 8.1 – 8.14 of text 1)
   (Chapter 17; Sections: 17.1 – 17. 9 of text – 2)
   (Chapter: 10; Sections: 10.1 – 10.12 of text – 3)
   (Chapter: 12; Sections: 12.1 – 12.7 of text – 4
   (Chapter: 18- Sections: 18.1 – 18.6 of text – 2)

Text Books for Enrichment

1. Thomas L Satty, Elementary Queuing Theory, McGraw Hill Publishing Company.
2. Narasingh Deo, System Simulationwirh digital Computers, 7th edition, Prentice Hall India Pvt. Ltd., 1997.
3. Geoffrey Gordon, System Simulation, 2nd edition Prentice Hall India Pvt. Ltd, 1998.

Course	Details				
Code	MT1924304				
Title	**Algorithmic Graph Theory**				
Degree	M Sc.				
Branch(s)	Mathematics				
Year/Semester	2/IV				
Type	Elective				
Credits	3	Hours/week	4	Total Hours	72

CO No.	*Expected Course Outcomes* *Upon completion of this course, the students will be able to:*	Cognitive Level	PSO No.
1	To learn the basic concepts of graph theory and algorithms to solve applied problems	C	5,6,7
2	Analyze whether or not two graphs are isomorphic or not	An	4,5
3	Understand how the search algorithm, sorting algorithm, and greedy algorithm works	An	3,7
4	Identify basic concepts of trees and rooted trees	U	2,3
5	Analyze Depth-First search and Breadth-First search.	E	1,3,7
6	Compute the distance in graphs and weighted graphs and find critical paths	Ap	3,5
7	Understanding the concepts of connectivity and edge connectivity	U	1,3,4
8	Compute the maximum flow in networks and find its application	E	2,5,7
9	Analyze matching problems	C	4,,5,6
10	Identify maximum matching in a bipartite graph	An	3
11	Understand factorization and block design	U	4,5

PSO – Programme Specific Outcome; CO-Course Outcome; Cognitive Level R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	Course Description	Hrs	CO.No.
1	**Introduction to Graphs and Algorithms**		
1.01	What is Graph?	2	1
1.02	The degree of a vertex	3	1
1.03	Isomorphic graphs	4	2
1.04	Sub-graphs, Degree sequences	3	1,2
1.05	Connected graphs	2	1
1.06	Cut-vertices and blocks	3	1
1.07	Special graphs and Digraphs	4	1,10

2	**Trees and paths**		
2.01	Algorithmic complexity	2	3
2.02	Search algorithms, Sorting algorithms, greedy algorithms	4	3
2.03	Representation of graphs in computer	2	1,3
2.04	Properties of trees, rooted trees	3	4
2.05	Depth first search-a tool for finding blocks	4	5
2.06	Breadth first search	4	5
2.07	The minimum spanning tree problem	3	5
3	**Distance and critical paths**		
3.01	Distance in a graph	2	6
3.02	Distance in weighted graphs	4	6
3.03	Centre and median of a graph	4	6
3.04	Activity digraphs and critical paths	5	6
4	**Networks**		
4.01	An introduction to networks	2	1,8
4.02	The max-flow min-cut theorem	4	8
4.03	The max-flow min-cut algorithms	5	8
4.04	Connectivity and edge connectivity	3	7
4.05	Mengers theorem	3	7
5	**Matchings and Factorizations**		
5.01	An introduction to matchings	2	9
5.02	Maximum matching in bipartite graphs	4	9, 10
5.03	Factorizations	5	11
5.04	Block Designs	4	11

Text Books:

1. Gray Chartrand and O.R Oellermann, Applied and Algorithmic Graph Theory, Tata McGraw-Hill Companies Inc

Text Books for Reference

1. Alan Gibbons, Algorithmic Graph Theory, Cambridge University Press,1985
2. Mchugh.J.A, Algorithmic Graph Theory, Prentice-Hall ,1990
3. Golumbic.M, Algorithmic Graph Theory and Perfect Graphs, Academic press