ALAGAPPA UNIVERSITY

(A State University Established in 1985)

Karaikudi - 630003. Tamil Nadu, India

2017 Accredited with A+ Grade by NAAC (CGPA : 3.64)

2018 MHRD Govt. of India UGC Graded as Category - I Granted Autonomy

2018 MHRD Swachh Campus Rank : 4

2021 nirf National Institutional Ranking Framework Rank : 33

2021 QS University Rankings Asia Rank : 199

FACULTY OF SCIENCE

DEPARTMENT OF MATHEMATICS

M.Sc., MATHEMATICS

REGULATIONS AND SYLLABUS

(For the candidates admitted from the Academic Year 2022 - 2023)

DEPARTMENT OF MATHEMATICS

M.Sc., Mathematics

SYLLABUS

[For the candidates admitted from the Academic Year 2022 – 2023 onwards]

ALAGAPPA UNIVERSITY

(A State University Accredited with "A+" grade by NAAC (CGPA: 3.64) in the Third Cycle andGraded as Category-I University by MHRD-UGC)

Karaikudi -630003, Tamil Nadu.

Panel of Members-Broad Based Board of Studies

Chairperson

Dr. N. Anbazhagan, Professor & Head, Department of Mathematics, Alagappa University, Karaikudi. Teaching Experience: 20 years, Research experience: 20 years, Area of Research: Stochastic Modeling, Data mining.

Foreign Experts

Dr. Rozaini Roslan, Professor, Department of Mathematics & Statistics,Faculty of Applied Sciences and Technology,Universiti Tun Hussein Onn Malaysia,Pagoh, Muar 84600, Malaysia., rozaini@uthm.edu.my .Working Experience: 20 Years, Research Experience: 20 Years, Area of Research: Fluid Mechanics, Heat and Mass Transfer, Nanofluids

Indian Experts

Dr. R. Uthayakumar, Professor and Head, Department of Mathematics, Gandhigram Rural Institute,Dindugal Teaching Experience: 24 years, Research experience: 24 Years, Area of Research: Fractal Theory, Operations Research, Inventory Management and Control

Dr. S. Muralisankar, Professor, Department of Mathematics, Madurai Kamaraj University, Madurai.Teaching Experience: 18 Years, Research experience: 18 Years, Area of Research: Fixed Point Theory,Fuzzy Functional Differential Equations, Stability analysis of Dynamical Systems

Members

Dr. J. Vimala, Assistant Professor, Department of Mathematics, Alagappa University, Karaikudi. Teaching Experience: 18 years, Research Experience: 15 years, Area of Research: Algebra –Lattice Theory, Fuzzy Algebra, Decision Theory and Soft computing.

Dr. R. Raja, Assistant Professor, Ramanujan Centre for Higher Mathematics, Alagappa University, Karaikudi. Teaching Experience: 11 Years, Research Experience: 10 years, Area of Research: Abstract & Fractional Differential Equations, Stability Analysis of Dynamical Systems, Neural Networks, Synchronization Theory, Mathematical Modeling and Population Systems, Genetic Regulatory Networks, Complex Dynamical Networks and Multi-Agent Systems.

Dr. B. Sundaravadivoo, Assistant Professor, Department of Mathematics, Alagappa University, Karaikudi. Teaching Experience: 19 years, Research Experience: 4 year, Area of Research: Abstract & Fractional Differential Equations, Control Theory, Mathematical Modelling and Perturbation Theory, Optimal Control.

Dr. S. Amutha, Assistant Professor, Ramanujan Centre for Higher Mathematics, Alagappa University, Karaikudi. Teaching Experience: 13 years, Research Experience: 13 years, Area of Research: Graph Theory, Domination Theory, Algorithmic Graph theory, Discrete Mathematics, Cryptography.

Dr. R. Jeyabalan, Assistant Professor, Department of Mathematics, Alagappa University, Karaikudi. Teaching Experience: 7 years, Research Experience: 7 years, Area of Research: Magic Labeling Graph Theory, Fuzzy Topology and Fuzzy Magic Labeling Graph Theory.

Dr. M. Mullai, Assistant Professor, Directorate of Distance Education, Alagappa University, Karaikudi. Teaching Experience: 18 years, Research Experience: 15 years, Area of Research: Algebra & Fuzzy Algebra, Operations Research, Mathematical Modelling, Neutrosophic sets (Neutrosophic Inventory, Neutrosophic Graph theory, Neutrosophic Optimization, Neutrosophic Adhoc networks)

Co opted Member from the Industry:

Mr. S. Gnanapandithan, Senior Manager ,Cognizant Technology Solutions, Coimbature, Robotic Process Automation Architect.

Alumni

Dr. A. Tamilselvan, Professor & Head, Department of Mathematics, Bharathidasan University, Tirchirapalli. Teaching Experience: 21 years, Research Experience: 21 years, Area of Research: DifferentialEquations, Numerical Analysis, Fractional Differential Equations, Finite Difference Methods, Finite VolumeMethods.

Ex-officio Member

Dr. V.Sivakumar, Professor and Co-ordinator, Curriculum Development Cell, Distance Education, Alagappa University, Karaikudi Teaching Experience: 24 years, Research Experience: 17 years, Area of Research: Marketing Management , Agricultural Marketing , International Logistics , Agricultural Logistics and SCM , Consumer Research.

ALAGAPPA UNIVERSITY

DEPARTMENT OF MATHEMATICS

Karaikudi -630003, Tamil Nadu.

REGULATIONS AND SYLLABUS-(CBCS-University Department)

[For the candidates admitted from the Academic Year 2022 – 2023 onwards]

Name of the Department : Mathematics

Name of the Programme : M.Sc., Mathematics

Duration of the Programme : Full Time (Two Years)

Choice-Based Credit System

A choice-Based Credit System is a flexible system of learning. This system allows students togain knowledge at their own tempo. Students shall decide on electives from a wide range of elective courses offered by the University Departments in consultation with the Department committee. Students undergo additional courses and acquire more than the required number of credits. They can also adopt an inter-disciplinary and intra-disciplinary approach to learning, and make the best use of the expertise of available faculty.

Programme

"Programme" means a course of study leading to the award of a degree in a discipline.

Courses

'Course' is a component (a paper) of a programme. Each course offered by the Department is identified by a unique course code. A course contains lectures/ tutorials/laboratory /seminar /project /practical training/report writing /Viva-voce, etc or a combination of these, to meet effectively the teaching and learning needs.

Credits

The term "Credit" refers to the weightage given to a course, usually in relation to the instructional hours assigned to it. Normally in each of the courses credits will be assigned on the basis of the number of lectures/tutorial/laboratory and other forms of learning required to complete the course contents in a 15-week schedule. One credit is equal to one hour of lecture per week. For laboratory/field work one credit is equal to two hours.

Semesters

An Academic year is divided into two **Semesters.** In each semester, courses are offered in 15 teaching weeks and the remaining 5 weeks are to be utilized for conduct of examination and evaluation purposes. Each week has 30 working hours spread over 5 days a week.

Departmental committee

The Departmental Committee consists of the faculty of the Department. The Departmental Committee shall be responsible for admission to all the programmes offered by the Department including the conduct of entrance tests, verification of records, admission, and evaluation. The Departmental Committee determines the deliberation of courses and specifies the allocation of credits semester-wise and course-wise. For each course, it will also identify the number of credits for lectures, tutorials, practicals, seminars etc. The courses (Core/Discipline Specific Elective/Non-Major Elective) are designed by teachers and approved by the Departmental Committees. Courses approved by the Departmental Committees shall be approved by the Board of Studies/Broad Based Board of Studies. A teacher offering a course will also be responsible for maintaining attendance and performance sheets (CIA -I, CIA-II, assignments and seminar) of all the students registered for the course. The Non-major elective programme, MOOCs coordinator and Internship Mentor are responsible for submitting the performance sheet to the Head of the department. The Head of the Department consolidates all such performance sheets of courses pertaining to the programmes offered by the department. Then forward the same to be Controller of Examinations.

Programme Educational Objectives (PEOs)

PEO-1	To apply precise, logical reasoning to problem solving.
PEO-2	To provide comprehensive curriculum to groom the students.
PEO-3	To inculcate innovative skills, team work, ethical practices to face the society.
PEO-4	To stimulate the students for future research.
PEO-5	To identify the challenging problems and find solutions.
PEO-6	To develop a multi-disciplinary approach for solving problems through core courses.
PEO-7	To teach the student with a broad understanding of mathematical equations and interactions with the numbers.
PEO-8	To plan future career through mathematical skills of the postgraduate study.
PEO-9	To teach to the pupils a basic understanding of mathematical concepts
PEO-10	To provide the pupils a challenging learning experience that emphasis new skills and information necessary to overcome obstacles in the mathematical world.

Programme Specific Objectives-(PSOs)

PSO-1	To provide the student with pertinent information in the field of Mathematics.
PSO-2	To include methods of facilitating learning such as projects, group work and participative learning
PSO-3	To establish inter-disciplinarily between Mathematics and other subjects from Humanities and the Social Sciences.
PSO-4	To assist in problem solving by teaching students how to apply mathematics to real-world scenarios.
PSO-5	To qualify national level competitive exams like CSIR-NET/GATE etc.

Programme Outcomes-(POs)

PO-1	**Disciplinary knowledge:** Capable of demonstrating comprehensive knowledge and understanding of one or more disciplines that form a part of a postgraduate programme of study.
PO-2	**Communication skills:** Ability to express thoughts and ideas effectively in writing and orally, communicate with others using appropriate media, confidently share one's views and by expressing herself/himself clearly; demonstrate the ability to listen carefully, read and write analytically, and present complex information in a clear and concise manner to different groups.
PO-3	**Critical thinking, Problem solving and Analytical reasoning:** Capability to apply analytic thought to a body of knowledge; analyse and evaluate evidence, arguments, claims, beliefs on the basis of empirical evidence; identify relevant assumptions or implications; formulate coherent arguments; critically evaluate practices, policies, theories and philosophies
PO-4	**Acquiring research-related skills, scientific reasoning and reflective thinking:** A sense of inquiry and capability for asking relevant/appropriate questions; ability to recognise cause and effect relationships, define problems, formulate and test hypotheses, analyse, interpret and draw conclusions from data; ability to plan, execute and report the results of an experiment or investigation.
PO-5	**Multicultural competence with moral and ethical awareness/ reasoning:** Possess knowledge of values and beliefs of multiple cultures and a global perspective; capability to effectively engage in a multicultural society and interact respectfully with diverse groups; ability to embrace moral/ethical values in one's life and career.
PO-6	**Cooperation/Team work with leadership qualities:** Ability to work effectively and respectfully with diverse teams; facilitate cooperative or coordinated effort on the part of a group, and act together as a group or a team in the interests of a common cause and work efficiently as a member of a team.
PO-7	**Self-directed lifelong learning with information/digital learning:** Capability to use ICT in a variety of learning situations; ability to work independently, identify appropriate resources required for a project; ability to acquire knowledge and skills, through self-paced and self- directed learning aimed at personal development.
PO-8	**Leadership Qualities:** Capability for mapping out the tasks of a team or an organization, and setting direction, formulating an inspiring vision, building a team who can help achieve the vision, motivating and inspiring team members to engage with that vision, and using management skills to guide people to the right destination in a smooth and efficient way.

PO-9	**Societal and Environment Concern:** understood, assessed and developed systems that meets the desired solutions considering societal and environmental factors. Create awareness to become an enlightened citizen with commitment to deliver one's responsibilities within the scope of bestowed rights and privileges.
PO-10	**Research Skills:** Prepare the students use mathematical theory, computational techniques, algorithms, and the latest computer technology to solve economic, scientific, engineering, physics, and business problems. Motivating the students to develop the knowledge of Mathematical software like MATLAB, MATHEMATICA, etc., by using in their research.

Programme Specific Outcomes-(PSOs)

PSO-1	Have strong foundation in core areas of Mathematics, and able to communicate Mathematics effectively.
PSO-2	Discuss the latest trends and applications pertinent to higher studies and employability.
PSO-3	Establish inter-disciplinary between Mathematics and other subjects from Science, Humanities and the Social Sciences.
PSO-4	Understanding of the fundamental axioms in mathematics and capability of developing ideas based on them.
PSO-5	Assist students in preparing (personal guidance, books) for competitive exams e.g. CSIR-NET, GATE, etc.

Eligibility for admission

A candidate who has passed the undergraduate course like B.Sc., Mathematics / B.Sc., Mathematics (Computer Applications) degree of this University or any of the above degree of any other University shall be eligible for admission in Master of Science (M.Sc.,) Degree in Mathematics of this University.Students will be admitted to the M.Sc. program either directly (Mode I) or through an entrance test (Mode II).

Minimum Duration of programme

The programme is for a period of two years. Each year shall consist of two semesters viz. Odd and Even semesters. Odd semesters shall be from June / July to October / November and even semesters shall be from November / December to April / May. Each Semester there shall be 90 working days consisting of 6 teaching hours per working day (5 days/week).

Components

A PG programme consists of a number of courses. The term "course" is applied to indicate a logicalpart of the subject matter of the programme and is invariably equivalent to the subject matter of a "paper" in the conventional sense. The following are the various categories of the courses suggestedfor the PG programmes:

A. Core courses (CC)- "Core Papers" means "the core courses" related to the programme concerned including practical and project work offered under the programme and shall cover core competency, critical thinking, analytical reasoning, and research skill.

B. Discipline-Specific Electives (DSE) means the courses offered under the programme related to the major but are to be selected by the students, shall cover additional academic knowledge, critical thinking, and analytical reasoning.

C. Non-Major Electives (NME)- Exposure beyond the discipline

- Students have to undergo a total of two Non Major Elective courses with 2 credits offered by other departments (one in II Semester another in III Semester).
- A uniform time frame of 3 hours on a common day (Tuesday) shall be allocated for the Non-Major Electives.
- Non Major Elective courses offered by the departments pertaining to a semester should be announced before the end of previous semester.
- Registration process: Students have to register for the Non-Major Elective course within 15 days from the commencement of the semester either in the department or NME portal (University website).

D. Self Learning Courses from MOOCs platforms.

- MOOCs shall be on voluntary for the students.
- Students have to undergo a total of 2 Self Learning Courses (MOOCs) one in II semester and another in III semester.
- The actual credits earned through MOOCs shall be transferred to the credit plan of programmes as extra credits. Otherwise 2 credits/course be given if the Self Learning Course (MOOCs) is without credit.
- While selecting the MOOCs, preference shall be given to the course related to employability skills.

E. Projects / Dissertation /Internships (Maximum Marks: 200**)**

The students shall undertake the dissertation work during the fourth semester.

- **Plan of work**

The candidate shall undergo Dissertation Work during the fourth semester. The candidate should prepare a scheme of work for the dissertation and should get approval from the guide. The candidate, after completing the dissertation work, shall be allowed to submit to the university at the end of the fourth semester. If the candidate is desirous of availing the facility from other universities/laboratory, they will be permitted only after getting approval from the guide. In such case, the candidate shall acknowledge the same in their dissertation.

Project/Dissertation

The candidate shall undergo Project/Dissertation Work during the final semester. The candidate should prepare a scheme of work for the dissertation/project and should get approval from the guide. The candidate, after completing the dissertation /project work, shall be allowed to submit it to the university departments at the end of the final semester. If the candidate is desirous of availing the facility from other departments/universities/laboratories/organizations they will be permitted only after getting approval from the guide and HOD. In such a case, the candidate shall acknowledge the same in their dissertation/project work.

- **Format to be followed for dissertation/project report**

The format /certificate for thesis to be followed by the student are given below

- Title page
- Certificate
- Acknowledgment
- Content as follows:

ChapterNo	Title	Page number
1	Introduction	
2	Aim and objectives	
3	Review of literature	
4	Materials and methods	
5	Result	
6	Discussion	
7	Summary	
8	References	

- **Format of the title page**

Title of Dissertation/Project work

Dissertation/Project submitted in partial fulfilment of the requirement for the degree of Master of Science to the Alagappa University, Karaikudi -630003.

By

(Student Name)

(Register Number)

University Logo

Department of ----------

Alagappa University

(State University | A+ Grade by NAAC (CGPA : 3.64) in the 3rd Cycle | Category - I University by MHRD – UGC)

Karaikudi - 630003

(Year)

- **Format of certificates**

Certificate -Guide

This is to certify that the **Dissertation/Project** entitled "----------" submitted to Alagappa University, Karaikudi-630 003 in partial fulfilment for the degreeof Master of Science in ---------- by Mr/Mrs ----------(Reg No----------) under my supervision. This is based on the results of studies carried out by him/her in the Department of----------, Alagappa University, Karaikudi-630 003. This Dissertation/Project or any part of this work has not been submitted elsewhere for any other degree,diploma, fellowship, or any other similar titles or record of any University or Institution.

Research Supervisor

Place:Karaikudi

Date:_____

Certificate - (HOD)

This is to certify that the thesis entitled **" ---------- "** submitted by Mr/Mis ----------(Reg No: ----------) to the Alagappa University, in partial fulfilment for the award of the degree of Master of --------in ---------- is a bonafide record of research work done under the supervision of Dr.----------, Assistant Professor,Department of ---------- , Alagappa University. This is to further certify that the thesis or any part thereof has not formed the basis of the award to the student of anydegree, diploma, fellowship, or any other similar title of any University or Institution.

Place: Karaikudi Head of the Department

Date:_____

Declaration (student)

I hereby declare that the dissertation entitled **" ---------- "** submitted to the Alagappa University for the award of the degree of Master of -------- in ------has been carried out by me under the guidance of Dr. **----------**, Assistant Professor, Department of ---------- , Alagappa University, Karaikudi – 630 003. This is my original and independent work and has not previously formed the basis of the award of any degree, diploma, associateship, fellowship, or any other similar title of any University or Institution.

Place: Karaikudi (_____)

Date:_____

Internship

The students shall undergo Internship / industrial training in the reputed organizations for minimum of two weeks to acquire industrial knowledge during the summer vacation of second semester. The students have to find industry related to their discipline (Public limited/Private Limited/owner/NGOs etc.,) in consultation with the faculty in charge/Mentor and get approval from the Head of the Department and Departmental Committee before going for an internship / industrial training.

- **Format to be followed for Internship report**

The format /certificate for internship report to be followed by the student are given below

- Title page -**Format of the title page**

Title of internship report

Internship report submitted in partial fulfilment of the requirement for the Master of degree in------ to the Alagappa University, Karaikudi -630003.

By

(Student Name)

(Register Number)

University Logo

Department of ----------

Alagappa University

((State University | A+ Grade by NAAC (CGPA : 3.64) in the 3rd Cycle | Category - I University by MHRD – UGC)

Karaikudi – 630003(Year)

- Certificate-(**Format of certificate – faculty in-charge)**

This is to certify that the report entitled " ---------- " submitted to Alagappa University, Karaikudi-630 003 in partial fulfilment for the Master of Science in ----------by Mr/Mis---------- (Reg No----------) under my supervision. This is based on the work carried out by him/her in the organization M/S----------. This Internship report or any part of this work has not been submitted elsewhere for any other degree, diploma, fellowship, or any other similar record of any University or Institution.

Place: Karaikudi Research Supervisor

Date:_____

Certificate (HOD)

This is to certify that the Internship report entitled **"----------"** submitted by Mr/Mis**.----------(Reg No----------)** to the Alagappa University, in partial fulfilment for the award of the Master of Science in-------- is a bonafide record of Internship report done under the supervision of----------, Assistant Professor, Department of----------, Alagappa University and the work carried out by him/her in the organization M/S ----------. This is to further certify that the thesis or any part thereof has not formed the basis of the award to the student of any degree, diploma, fellowship, or any other similar title of any University or Institution.

Place: Karaikudi Head of the Department

Date:_____

- Certificate-(**Format of certificate – Company supervisor or Head of the Organization)**

This is to certify that the Internship report entitled "----------" submitted to Alagappa University, Karaikudi-630 003 in partial fulfilment for the Master of Science in ----------by Mr/Mis---------- (Reg No---------) under my supervision. This is based on the work carried out by him/her in our organization M/S ---------- for the period of three months or ------. This Internship report or any part of this work has not been submitted elsewhere for any other degree, diploma, fellowship, or any other similar record of any University or Institution.

Place: Karaikudi Supervisor in charge

Date:_____

Declaration (student)

I hereby declare that the Internship Report entitled **"----------"** submitted to the Alagappa University for the award of the **Master of Science in----------** has been carried out by me under the supervision of---------- , Assistant Professor, Department of----------, Alagappa University, Karaikudi – 630 003. This is my original and independent work carried out by me in the organization M/S ---------- for theperiod of three months or ---------- and has not previously formed the basis of the award of any degree, diploma, associateship, fellowship, or any other similar title of any University orInstitution.

Place: Karaikudi (_____)

Date:_____

- Acknowledgment
- Content as follows:

Chapter No	Title	Page number
1	Introduction	
2	Aim and objectives	
3	Organisation profile /details	
4	Methods / Work	
5	Observation and knowledge gained	
6	Summary and outcome of the Internship study	
7	References	

- **No. of copies of the dissertation/internship report**

The candidate should prepare three copies of the dissertation report and submit the same for the evaluation of examiners. After evaluation, one copy will be retained in the department library, one copy will be retained by the guide and the student shall hold one copy. The candidate should prepare one copy of the field visit/internship report and submit the same for the evaluation of examiners.

Teaching methods

The method of teaching is by giving lectures, tutorials, seminars and supervised research projects. Moreover, extensive use is made of IT and a wide range of materials is available to enable students to study at their own place and in their own time to enhance and extend the material taught formally.

Attendance

Students must have earned 75% of attendance in each course for appearing for the examination. Students who have earned 74% to 70% of attendance need to apply for condonation in theprescribed form with the prescribed fee. Students who have earned 69% to 60% of attendance need to apply for condonation in the prescribed form with the prescribed fee along with the Medical Certificate. Students who have below 60% of attendance are not eligible to appear for the End Semester Examination (ESE). They shall re- do the semester(s) after completion of theprogramme.

Examination

The examinations shall be conducted separately for theory and practicals to assess (remembering, understanding, applying, analysing, evaluating, and creating) the knowledge required during the study. There shall be two systems of examinations viz., internal and external examinations. The internal examinations shall be conducted as Continuous Internal Assessment tests I and II (CIA Test I & II).

F. Internal Assessment

The internal assessment shall comprise a maximum of 25 marks for each subject. Thefollowing procedure shall be followed for awarding internal marks.

Theory -25 marks

Sr.No	Content	Marks
1	Average marks of two CIA test	15
2	Seminar/group discussion/quiz	5
3	Assignment/field trip report/case study report	5
	Total	25

Practical -25 Marks

1	Major Experiment	10 marks
2	Minor Experiment	5 marks
3	Spotter (2x 5/ 4 x4) or any other mode	10 marks
	Total	25 Marks

Project/Dissertation/internship-50 Marks (assess by Guide/incharge/HOD/supervisor)

1	Two presentations (mid-term)	30 Marks
2	Progress report	20 Marks
	Total	50 Marks

G. External Examination

- There shall be examinations at the end of each semester, for odd semesters in the month of October / November; for even semesters in April / May.
- A candidate who does not pass the examination in any course(s) may be permitted to appear in such failed course(s) in the subsequent examinations to be held in October / November or April / May. However candidates who have arrears in Practical shall be permitted to take their arrear Practical examination only along with Regular Practical examination in the respective semester.

- A candidate should get registered for the first semester examination. If registration is not possible owing to shortage of attendance beyond condonation limit / regulation prescribed OR belated joining OR on medical grounds, the candidates are permitted to move to the next semester. Such candidates shall re-do the missed semester after completion of the programme.
- For the Project Report/ Dissertation Work / internship the maximum marks will be 150 marks for project report evaluation and for the Viva-Voce it is 50 marks (if in some programmes, if the project is equivalent to more than one course, the project marks would be in proportion to the number of equivalent courses).
- Viva-Voce: Each candidate shall be required to appear for Viva-Voce Examination (in defense of the Dissertation Work /Project/ internship).

H. Scheme of External Examination (Question Paper Pattern)

Theory - Maximum 75 Marks

Section A	10 questions. All questions carry equal marks. (Objective type questions)	10 x 1 = 10 Marks	10 questions – 2 each from every unit
Section B	5 questions Either / or type like 1.a (or) b. All questions carry equal marks	5 x 5 = 25	5 questions – 1 each from every unit
Section C	5 questions Either / or type like 1.a (or) b. All questions carry equal marks	5 x 8 = 40	5 questions – 1 eachfrom every unit

Dissertation /Project report/Internship report Scheme of evaluation

Dissertation /Project report/Internship report	150 Marks
Viva voce	50 Marks

Results

The results of all the examinations will be published through the Department where the student underwent the course as well as through University Website

Passing minimum

A candidate shall be declared to have passed in each course if he/she secures not less than 40% marks in the End Semester Examinations and 40% marks in the Internal Assessment and not less than 50% in the aggregate, taking Continuous assessment and End Semester Examinations marks together.

The candidates not obtained 50% in the Internal Assessment are permitted to improve their Internal Assessment marks in the subsequent semesters (2 chances will be given)by writing the CIA tests and by submitting assignments.

Candidates, who have secured the pass marks in the End-Semester Examination and in the CIA but failed to secure the aggregate minimum pass mark (E.S.E + C I.A), are permitted to improve their Internal Assessment mark in the following semester and/or in University examinations.

A candidate shall be declared to have passed in the Project / Dissertation / Internship if he /she gets not less than 40% in each of the Project / Dissertation / Internship Report and Viva-Voce and not less than 50% in the aggregate of both the marks for Project Report and Viva-Voce.

A candidate who gets less than 50% in the Project / Dissertation / Internship Report must resubmit the thesis. Such candidates need to take again the Viva-Voce on the resubmitted Project report.

Grading of the Courses

The following table gives the marks, Grade points, Letter Grades and classifications meant to indicate the overall academic performance of the candidate.

Conversion of Marks to Grade Points and Letter Grade (Performance in Paper / Course)

RANGE OF MARKS	GRADE POINTS	LETTER GRADE	DESCRIPTION
90 - 100	**9.0 – 10.0**	**O**	**Outstanding**
80 - 89	**8.0 – 8.9**	**D+**	**Excellent**
75 - 79	**7.5 – 7.9**	**D**	**Distinction**
70 - 74	**7.0 – 7.4**	**A+**	**Very Good**
60 - 69	**6.0 – 6.9**	**A**	**Good**
50 - 59	**5.0 – 5.9**	**B**	**Average**
00 - 49	**0.0**	**U**	**Re-appear**
ABSENT	**0.0**	**AAA**	**ABSENT**

a) Successful candidates passing the examinations and earning GPA between 9.0 and 10.0 and marks from 90 – 100 shall be declared to have Outstanding (O).

b) Successful candidates passing the examinations and earning GPA between 8.0 and 8.9 and marks from 80 - 89 shall be declared to have Excellent (D+).

c) Successful candidates passing the examinations and earning GPA between 7.5 – 7.9 and marks from 75 - 79 shall be declared to have Distinction (D).

d) Successful candidates passing the examinations and earning GPA between 7.0 – 7.4 and marks from 70 - 74 shall be declared to have Very Good (A+).

e) Successful candidates passing the examinations and earning GPA between 6.0 – 6.9 and marks from 60 - 69 shall be declared to have Good (A).

f) Successful candidates passing the examinations and earning GPA between 5.0 – 5.9 and marks from 50 - 59 shall be declared to have Average (B).

g) Candidates earning GPA between 0.0 and marks from 00 - 49 shall be declared to have Re-appear (U).

h) Absence from an examination shall not be taken as an attempt.

From the second semester onwards the total performance within a semester and continuous performance starting from the first semester are indicated respectively **by Grade Point Average (GPA) and Cumulative Grade Point Average (CGPA).** These two are calculated by the following formulate

GRADE POINT AVERAGE (GPA) = $\Sigma_i C_i \ G_i / \Sigma_i C_i$

GPA = Sum of the multiplication of Grade Points by the credits of the courses
Sum of the credits of the courses in a Semester

Classification of the final result

CGPA	Grade	Classification of Final Result
9.5 – 10.0	**O+**	First Class – Exemplary*
9.0 and above but below 9.5	**O**	
8.5 and above but below 9.0	**D++**	First Class with Distinction*
8.0 and above but below 8.5	**D+**	
7.5 and above but below 8.0	**D**	
7.0 and above but below 7.5	**A++**	First Class
6.5 and above but below 7.0	**A+**	
6.0 and above but below 6.5	**A**	
5.5 and above but below 6.0	**B+**	Second Class
5.0 and above but below 5.5	**B**	
0.0 and above but below 5.0	**U**	Re-appear

The final result of the candidate shall be based only on the CGPA earned by the candidate.

a) Successful candidates passing the examinations and earning CGPA between 9.5 and 10.0 shall be given Letter Grade (O+), those who earned CGPA between 9.0 and 9.4 shall be given Letter Grade (O) and declared to have First Class –Exemplary*.

b) Successful candidates passing the examinations and earning CGPA between 7.5 and 7.9 shall be given Letter Grade (D), those who earned CGPA between 8.0 and 8.4 shall be given Letter Grade (D+), those who earned CGPA between 8.5 and 8.9 shall be given Letter Grade (D++) and declared to have First Class with Distinction*.

c) Successful candidates passing the examinations and earning CGPA between 6.0 and 6.4 shall be given Letter Grade (A), those who earned CGPA between 6.5 and 6.9 shall be given

Letter Grade (A+), those who earned CGPA between 7.0 and 7.4 shall be given Letter Grade (A++) and declared to have First Class.

d) Successful candidates passing the examinations and earning CGPA between 5.0 and 5.4 shall be given Letter Grade (B), those who earned CGPA between 5.5 and 5.9 shall be given Letter Grade (B+) and declared to have passed in Second Class.

i) Candidates those who earned CGPA between 0.0 and 4.9 shall be given Letter Grade (U) and declared to have Re-appear.

e) Absence from an examination shall not be taken as an attempt.

CUMULATIVE GRADE POINT AVERAGE (CGPA) = $\Sigma_n \Sigma_i C_{ni} G_{ni} / \Sigma_n \Sigma_i C_{ni}$

CGPA = Sum of the multiplication of Grade Points by the credits of the entire Programme

Sum of the credits of the courses for the entire Programme

Where '**Ci**' is the Credit earned for Course i in any semester; '**Gi**' is the Grade Point obtained by the student for Course i and 'n' refers to the semester in which such courses were credited.

CGPA (Cumulative Grade Point Average) = Average Grade Point of all the Courses passed starting from the first semester to the current semester.

Note: * The candidates who have passed in the first appearance and within the prescribed Semesters of the PG Programme are alone eligible for this classification.

Maximum duration of the completion of the programme

The maximum period for completion of **M.Sc.,** in **Mathematics** shall not exceed eight semesters continuing from the first semester.

Conferment of the Master's Degree

A candidate shall be eligible for the conferment of the Degree only after he/ she has earned the minimum required credits for the Programme prescribed therefor (i.e. 90 credits). Programme).

Village Extension Programme

The Sivaganga and Ramnad districts are very backward districts where a majority of people Lives in poverty. The rural mass is economically and educationally backward. Thus the aim of the introduction of this Village Extension Programme is to extend out to reach environmental awareness, social activities, hygiene, and health to the rural people of this region. The students in their third semester have to visit any one of the adopted villages within the jurisdiction of Alagappa University and can arrange various programs to educate the rural mass in the following areas for three day based on the theme.1. Environmental awareness 2. Hygiene and Health. A minimum of two faculty members can accompany the students and guide them.

M.Sc. MATHEMATICS-PROGRAMME STRUCTURE

S. No	Paper Code	Title of the paper		T/P	Credits	Hours/ Week	Marks		
		I Semester					**I**	**E**	**Total**
1	511101	Core 1	Groups & Rings	T	5	6	25	75	100
2	511102	Core 2	Real Analysis - I	T	5	6	25	75	100
3	511103	Core 3	Ordinary Differential Equations	T	5	6	25	75	100
4	511104	Core 4	Analytic Number Theory	T	5	6	25	75	100
5		Elective	Elective-I	T	5	5	25	75	100
		Library / Yoga/ counselling/Field trip				1			
					25	**30**	**125**	**375**	**500**
		II Semester							
6	511201	Core 5	Linear Algebra	T	5	6	25	75	100
7	511202	Core 6	Real Analysis – II	T	5	6	25	75	100
8	511203	Core 7	Complex Analysis	T	5	5	25	75	100
9	511204	Core 8	Partial Differential Equations	T	5	5	25	75	100
10		Elective	Elective-II	T	5	5	25	75	100
11		Non-Major Elective **		T	2	3	25	75	100
12		Self-learning course (SLC) –MOOCs***			Extra credit				
					27	**30**	**150**	**450**	**600**
		III Semester							
13	511301	Core 9	Classical Dynamics	T	5	6	25	75	100
14	511302	Core 10	Topology	T	5	6	25	75	100
15	511303	Core 11	Calculus of Variations & Integral Equations	T	5	6	25	75	100
16		Elective	Elective-III	T	5	6	25	75	100
17		Non-Major Elective **			2	3	25	75	100
		Library/Yoga				3			
18		Self-learning course (SLC) –MOOCs***			Extra credit				
					22	**30**	**125**	**375**	**500**
		IV Semester							
19	511401	Core 12	Functional Analysis	T	5	5	25	75	100
20	511402	Core 13	Probability and Statistics	T	5	5	25	75	100
21	511403	Core 14	Graph Theory	T	5	5	25	75	100
22	511404	Core 15	Measure and Integration	T	5	5	25	75	100
23	511999	Core 16	Dissertation Work		5	10	25	75	100
					25	**30**	**125**	**375**	**500**
			Total		**99**		**525**	**1575**	**2100**

DSE (Discipline Specific Elective)– Student Choice and it may be conducted by parallel sections.

** NME –Student have to select courses offered by other (Faculty) departments.

*** SLC- Voluntary basis

*** Dissertation / internship report–Marks-(Viva-voce (50) + Dissertation (150))/2 = 100

T-Theory

P-Practical

Major Elective –Courses offered to the other Department to other Departments

S. No	Paper Code	Semester	Title of the paper	Credits	Hours/ Week	Marks		
						I	E	T
1	511501	I	Differential Geometry	5	5	25	75	100
2	511502	I	Theory of Automata and Formal Languages	5	5	25	75	100
3	511503	I	Combinatorics	5	5	25	75	100
4	511504	I	Fluid Dynamics	5	5	25	75	100
5	511505	I	Object oriented programming and C++	5	5	25	75	100
6	511506	I	Skills in Latex	5	5	25	75	100
7	511507	II	Numerical Analysis	5	5	25	75	100
8	511508	II	Multivariate Calculus	5	5	25	75	100
9	511509	II	Algorithmic Graph Theory	5	5	25	75	100
10	511510	II	Introduction to Python Programming	5	5	25	75	100
11	511511	II	MATLAB	5	5	25	75	100
12	511512	II	Financial Mathematics	5	5	25	75	100
13	511513	III	Stochastic Processes	5	5	25	75	100
14	511514	III	Algebraic Number theory	5	5	25	75	100
15	511515	III	Theory of Operators	5	5	25	75	100
16	511516	III	Coding Theory	5	5	25	75	100
17	511517	III	Data Analytics	5	5	25	75	100
18	511518	III	Optimization Techniques	5	5	25	75	100

Non-Major Elective –Courses offered to the other Department to other Departments

S. No	Paper Code	Semester	Title of the paper	Credits	Hours/ Week	Marks		
						I	E	T
1		II	Resource Management Techniques	2	3	25	75	100
2		II	Methods of Mathematical Physics	2	3	25	75	100
3		II	Classical Mechanics	2	3	25	75	100
4		III	Discrete Mathematics	2	3	25	75	100
5		III	Descriptive Statistics	2	3	25	75	100
6		III	Biostatistics	2	3	25	75	100

Courses:

I	Semester	=	25 Credits	(Core: 20; Major Elective: 5)
II	Semester	=	27 Credits	(Core: 20; Major Elective: 5; Non-Major Elective: 2)
III	Semester	=	22 Credits	(Core: 15; Major Elective: 5; Non-Major Elective: 2)
IV	Semester	=	25 Credits	(Core: 20; Dissertation Work: 5)
Total credits		**=**	**99+ Extra credits**	**(Core: 75; Major Elective: 15; Non-Major Elective: 4; Dissertation Work: 5 + MOOCs extra credits)**

I - Semester					
Core	**Course code: 511101**	**Groups and Rings**	**T**	**Credits:5**	**Hours:6**

Unit-1

Objective 1	To familiarize basic information about Groups and Subgroups	
Definition of a group- Some examples of groups–Some preliminary lemmas.Subgroups–A counting principle		
Outcome 1	Learners understand the fundamental concepts of Groups	**K2**

Unit-2

Objective 2	To provide Knowledge in Normal subgroups, Quotient groups, and Morphisms	
Normal subgroups and Quotient groups-Homomorphism, Automorphisms – Cayley's Theorem		
Outcome 2	Students discuss about homomorphism, and automorphism among groups	**K4**

Unit-3

Objective 3	To educate on the above-mentioned concepts in Sylow's Theorems, Direct Products.	
Permutation groups–Another counting principle - **Sylow's theorem**–Direct products		
Outcome 3	Students analyze the recent concepts in Permutation groups and Sylow's theorem.	**K4**

Unit-4

Objective 4	To learn the knowledge about rings and their techniques	
Definition and Examples of Rings–Some Special Classes of Rings- Homomorphisms–Ideals and Quotient Rings– More Ideals and Quotient Rings.		
Outcome 4	Learners can gain knowledge on the technique of rings.	**K2**

Unit-5

Objective 5	To educate about the Euclidean rings and Polynomial rings	
The field of Quotients of an Integral Domain –Euclidean Rings-A Particular Euclidean Ring-Polynomial rings-Polynomial over the Rational field- Polynomial Rings over Commutative Rings.		
Outcome 5	Learners evaluate the recent trends in Euclidean rings, polynomial rings.	**K5**

Suggested Readings:

Herstein,I.N. (2017). *Topics in Algebra*(2nd ed.).JohnWiley&Sons.

Artin,M.(1991).*Algebra*. Prentice Hall of India, New Delhi.

Bhattacharya, P.B., Jain S.K., Nagpaul. S.R. (1995). *Basic Abstract Algebra*. Cambridge.

University Press.JohnFraleigh, B. (1982).*Afirstcoursein AbstractAlgebra*. Addison-Wesley, MA.

Online resources:

nptel.ac.in

udemy.com/course/abstract-algebra-group-theory-with-the-math-sorcerer/

K1-Remember	**K2 - Understand**	**K3 - Apply**	**K4- Analyze**	**K5 - Evaluate**	**K6 – Create**

Course designed by: Dr. J. Vimala

Course Outcome VS Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	L(1)	L(3)	M(2)	M(2)	M(2)	S(3)	L(1)	S(3)	L(1)	L(1)
CO2	L(1)	M(2)	S(3)	L(1)	M(2)	S(3)	M(2)	M(2)	M(2)	L(1)
CO3	M(2)	M(2)	S(3)	M(2)	L(1)	S(3)	M(2)	L(1)	M(2)	M(2)
CO4	S(3)	M(2)	S(3)	S(3)	M(2)	S(3)	M(2)	M(2)	L(1)	L(1)
CO5	M(2)	S(3)	M(2)	S(3)	M(2)	S(3)	M(2)	M(2)	S(3)	L(1)
AVG	**1.8**	**2.4**	**2.6**	**2.2**	**1.8**	**3**	**1.8**	**2**	**1.8**	**1.2**

S- Strong(3), M-Medium(2), L-Low(1)

Course Outcome VS Programme Specific Outcomes

CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M(2)	S(3)	L(1)	M(2)	M(2)
CO2	M(2)	L(1)	M(2)	L(1)	M(2)
CO3	L(1)	M(2)	M(2)	S(3)	M(2)
CO4	M(2)	M(2)	M(2)	M(2)	M(2)
CO5	M(2)	S(3)	M(2)	M(2)	M(2)
AVG	**1.8**	**2.2**	**1.8**	**2**	**2**

S-Strong(3), M-Medium(2), L-Low(1)

Semester – I					
Core	**Course Code: 511102**	**Real Analysis – I**	**T**	**Credits: 5**	**Hours: 6**

Unit-I

Objective 1	Prove various statements by induction and emphasize the proofs' development.	
Basic Topology: Ordered Sets - Finite, Countable and uncountable sets – Metric spaces – compactspaces – Perfect sets – Connected sets.		
Outcome 1	Explain the fundamental properties of the field of real numbers. Improve and outline the logical thinking.	**K2**

Unit-II

Objective 2	Define the limit of a function at a value, a limit of a sequence, and the Cauchy criterion.	
Numerical sequences and series: Convergent sequences – Subsequences – Cauchy sequences – Upperand lower limits – Some special sequences – Series – Series of nonnegative terms.		
Outcome 2	Identify the properties of metric space, sequences, series, continuity, uniform continuity and differentiation in real line and recognize the series of real numbers, convergence shown the ability of working independently and with groups.	**K3**

Unit-III

Objective 3	Prove various theorems about limits of sequences and functions and emphasize the proofs' development.	
Numerical sequences and series (Conti): The number 'e' – The root and ratio tests – Power series – Summation by parts – Absolute convergence – Addition and multiplication of series – Rearrangements.		
Outcome 3	Apply the ratio test, root test and comparison test to determine the convergence of series.	**K4**

Unit-IV

Objective 4	Prove various theorems about the derivatives of functions and emphasize the proofs' development. Discuss vector valued functions (i.e. functions with values in RK) and functions with values in an arbitrary metric space.	
Continuity – Limits of functions – Continuous functions – Continuity and compactness – Continuity and connectedness – Discontinuities – Monotonic functions – Infinite limits and limits at infinity.		
Outcome 4	Explain and illustrate the concepts of continuity, differentiability, integrability, convergence, sequence and series of functions and some special functions and analyze the characteristics and equivalence criterions of various concepts in the context of extended real number system.	**K5**

Unit-V

Objective 5	Prove the Bolzano-Weierstrass theorem, Rolle's theorem, extreme value theorem, and the Mean Value theorem and emphasize the proofs' development	
Differentiation – The Derivative of a real function – Mean value theorems – The Continuity of derivatives – L'Hospital's Rule – Derivatives of Higher order – Taylor's theorem – Differentiation of vector valued functions.		
Outcome 5	Demonstrate the limit process in sequences, series, differentiation and integration. Also establish various theorems, results and corollaries of real number system. Define and recognize Bolzano- Weirstrass theorem. Ability to apply the theorem in a correct mathematical way and appreciate how abstract ideas and rigorous methods in mathematical analysis can be applied to important practical problems.	**K6**

Suggested Readings:

Walter Rudin. (2016). *Principles of Mathematical Analysis* (3rd ed.). New York : McGraw-Hill.

Apostol, T.M. (1985). *Mathematical Analysis* (2nd ed.). New Delhi: Narosa Publ. House.

Donald Sherbert, R., Robert Bartle, G. (2014). *Introduction to Real Analysis* (4th ed.). Wiley.

Edward Gaughan, D. (2010). *Introduction to Analysis* (5th ed.). American Mathematical Society.

V. Ganapathy Iyer (1970), *Mathematical Analysis*, New Delhi, Tata McGraw Hill.

H.L. Royden, (1993), *Real Analysis* (4th ed.), New York, Macmillan Publ. Co. Inc.

Online resources					
https://arcieve.nptel.ac.in/courses/111/106/1111006053/ https://ocw.mit.edu/courses/18-100c-real-analysis-fall-2012/ https://onlinecouses.swayam2.ac.in/cec22_ma11/preview https://www.classcentral.com/course/swayam-real-analysis-i-19987					
K1-Remember	*K2-Understand*	*K3- Apply*	*K4-Analyze*	*K5-Evaluate*	*K6-Create*
Course Designed by: Dr. S. Amutha					

Course Outcome VS Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S(3)	L(1)	S(3)	M(2)	S(3)	S(3)	S(3)	M(2)	S(3)	S(3)
CO2	M(2)	L(1)	S(3)	L(1)	S(3)	S(3)	S(3)	L(1)	S(3)	S(3)
CO3	S(3)	M(2)	S(3)	L(1)	S(3)	S(3)	S(3)	L(1)	S(3)	S(3)
CO4	L(1)	M(2)	S(3)	M(2)	S(3)	S(3)	S(3)	M(2)	S(3)	S(3)
CO5	S(3)	L(1)	M(2)	S(3)	S(3)	S(3)	M(2)	S(3)	S(3)	S(3)
AVG	**2.4**	**1.4**	**2.8**	**1.8**	**3**	**3**	**2.8**	**1.8**	**3**	**3**

S- Strong (3), M- Medium(2), L-Low(1)

Course Outcome VS Programme Specific Outcomes

CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S(3)	M(2)	S(3)	M(2)	L(1)
CO2	S(3)	M(2)	S(3)	M(2)	L(1)
CO3	S(3)	M(2)	S(3)	M(2)	L(1)
CO4	S(3)	M(2)	S(3)	M(2)	L(1)
CO5	S(3)	M(2)	S(3)	M(2)	L(1)
AVG	**3**	**2**	**3**	**2**	**1**

S- Strong (3), M- Medium(2), L-Low(1)

I - Semester					
Core	**Course code: 511103**	**Ordinary Differential Equations**	**T**	**Credits:5**	**Hours:6**

Unit I

Objective 1	Formulate ordinary differential equations (ODEs) and seek understanding of their solutions, either obtained exactly or approximately by analytic or numerical methods.

Linear equations with constant coefficients: Linear dependence and Independence-A formula for the Wronskian- Non-homogeneous equation-Homogeneous equation of order n-initial value problems for n^{th} order equations-Equations with real constants- Non-homogeneous equation of order n.

Outcome1	Apply the fundamental concepts of ordinary differential equations and the basic numericalmethods for their resolution.	**K2**

Unit II

Objective 2	Understand the concept of a solution to an initial value problem, and to guarantee the existence and uniqueness under specific conditions.

Linear equations with variable coefficients: Reduction of the order of a homogeneous equation- Non-homogeneous equation-Homogeneous equations with analytic coefficients- Legendre equation.

Outcome2	Understand the difficulty of solving problems analytically and the need to use the numericalapproximations for their resolution.	**K4**

Unit III

Objective 3	Recognize the basic types of differential equations which are solvable, and will understand the features of linear equations in particular.

Linear equations with regular singular points: Euler equation - Second order equations with regular singular points - An example-second order equations with regular singular points - General case-exceptional cases- Bessel equation- Bessel equation (continued) - Regular singular points at infinity.

Outcome3	Use computational tools to solve problems and applications of ordinary differential equationsand partial differential equations.	**K6**

Unit IV

Objective 4	Use different approaches to investigate the equations which are not easily solvable. In particular, the student will be familiar with phase plane analysis.

Existence and uniqueness of solutions to first order equations: Equations with variables separated- Exact equations- Method of successive approximations- Lipschitz condition - Convergence of the successive approximations.

Outcome 4	Formulate and solve differential equation problems in the field of industrial organization engineering.	**K3**

Unit V

Objective 5	Solve the problems by choosing the most suitable method.

Nonlocal existence of solutions: Approximations to solutions and uniqueness of solutions - Existence and uniqueness of solutions to systems and nth order equations - Existence and uniqueness of solutions to systems.

Outcome 5	Use an adequate scientific language to formulate the basic concepts of the course.	**K5**

Suggested Readings:

Earl A. Coddington.(1987). *An Introduction to Ordinary Differential Equations* - Prentice Hall of India.

James B. Robinson. (2004). *An Introduction to Ordinary Differential Equations*, Cambridge University Press.

R.P Agarwal and Ramesh C. Gupta. (1991). *Essentials of Ordinary Differential Equation*. McGraw, Hill, New York.

D. Somasundram. (2002). *Ordinary Differential Equations*, Narosa Publ. House, Chennai.

D. Raj, D.P. Choudhury and H.I. Freedman. (2004). *A Course in Ordinary Differential Equations*, Narosa Publ. House,Chennai.

Online resources

https://ocw.mit.edu/courses/18-03-differential-equations-spring-2010/

https://www.classcentral.com/course/swayam-differential-equations-93298

K1-Remember	*K2-Understand*	*K3- Apply*	*K4-Analyze*	*K5-Evaluate*	*K6-Create*

Course Designed by: Dr.R.Raja

Course Outcome VS Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S(3)	M(2)	S(3)	S(3)	S(3)	S(3)	M(2)	S(3)	L(1)	S(3)
CO2	S(3)	S(3)	S(3)	M(2)	S(3)	S(3)	S(3)	M(2)	S(3)	S(3)
CO3	S(3)	S(3)	S(3)	S(3)	L(1)	S(3)	S(3)	S(3)	M(2)	S(3)
CO4	S(3)	S(3)	L(1)	S(3)	S(3)	S(3)	M(2)	S(3)	S(3)	M(2)
CO5	M(2)	S(3)	S(3)	S(3)	S(3)	S(3)	S(3)	M(2)	S(3)	S(3)
AVG	**2.8**	**2.8**	**2.6**	**2.8**	**2.6**	**3**	**2.6**	**2.6**	**2.4**	**2.8**

S –Strong (3), M-Medium (2), L- Low (1)

Course Outcome VS Programme Specific Outcomes

CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S(3)	M(2)	S(3)	L(1)	S(3)
CO2	S(3)	S(3)	S(3)	M(2)	S(3)
CO3	S(3)	S(3)	M(2)	S(3)	S(3)
CO4	M(2)	L(1)	S(3)	S(3)	S(3)
CO5	S(3)	S(3)	L(1)	S(3)	M(2)
AVG	**2.8**	**2.4**	**2.4**	**2.4**	**2.8**

S –Strong (3), M-Medium (2), L- Low (1)

I - Semester					
Core	**Course code: 511104**	**Analytic Number Theory**	**T**	**Credits: 5**	**Hours:6**
Unit -I					
Objective 1	Focus on the definition of Divisibility				
The fundamental theorem of Arithmetic – Arithmetic Function and Dirichlet multiplication					
Outcome1	Learners acquire the knowledge on divisibility of numbers.				**K2**
Unit II					
Objective 2	Introducing different types of arithmetic functions				
Averages of Arithmetic Functions					
Outcome2	Students understand the theory of Arithmetic functions				**K4**
Unit III					
Objective 3	Aim to introduce prime number theorem				
Some elementary theorems on the distributions of prime numbers					
Outcome3	Understand the proof of Prime number theorem.				**K2**
Unit IV					
Objective 4	To investigate the congruence relations				
Congruences.					
Outcome4	To consolidate earlier knowledge of congruence through applications.				**K4**
Unit V					
Objective 5	To illustrate how general methods of quadratic reciprocity law can be used for Jacobisymbol				
Quadratic residues and the quadratic reciprocity law					
Outcome5	Understand the applications of Gauss Lemma.				**K5**

Suggested Readings:

Tom Apostol, M. (2010). *Introduction to Analytic Number Theory*. New Delhi: Narosa.

Burton, D.M. (2001). *Elementary Number Theory* (7th ed.). New Delhi: Universal Book

Stall.Davenport, H. (2000). *Multiplicative Number Theory* (3rd ed.). Springer.

Ireland, K., Rosen, M. (1972). *A Classical Introduction to Modern Number Theory*. New York: Springer Verlag.

Ivan Niven, Zuckerman, H.S. (1989). *An Introduction to the Theory of Numbers* (5th ed.). New Delhi: Wiley Eastern Ltd..

Montgomery, H.L. Vaughan, R.C., (2012). *Multiplicative Number Theory. I. Classical Theory*. Cambridge University Press.

Online resources: Number Theory Web, MathSciNet, Zentralblatt, Math arXiv

K1-Remember	*K2-Understand*	*K3- Apply*	*K4-Analyze*	*K5-Evaluate*	*K6-Create*

Course Designed by: Dr. B. Sundaravadivoo

Course Outcome VS Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	L(1)	M(2)	M(2)	M(2)	S(3)	M(2)	S(3)	M(2)	M(2)	L(1)
CO2	M(2)	M(2)	L(1)	M(2)	S(3)	S(3)	S(3)	M(2)	S(3)	M(2)
CO3	L(1)	M(2)	M(2)	M(2)	S(3)	S(3)	S(3)	M(2)	M(2)	L(1)
CO4	M(2)	L(1)	M(2)	S(3)	S(3)	M(2)	S(3)	M(2)	M(2)	M(2)
CO5	M(2)	L(1)	S(3)	S(3)	S(3)	M(2)	S(3)	M(2)	S(3)	M(2)
AVG	**1.6**	**1.6**	**2**	**2.4**	**3**	**2.4**	**3**	**2**	**2.4**	**1.6**

S –Strong S(3), M-Medium M(2), L- Low (1)

Course Outcome VS Programme Specific Outcomes

CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	L(1)	M(2)	M(2)	M(2)	S(3)
CO2	L(1)	M(2)	S(3)	M(2)	S(3)
CO3	L(1)	M(2)	M(2)	M(2)	S(3)
CO4	L(1)	M(2)	M(2)	S(3)	S(3)
CO5	M(2)	S(3)	S(3)	S(3)	S(3)
AVG	**1.2**	**2.2**	**2.4**	**2.4**	**3**

S –Strong (3), M-Medium M(2), L- Low (1)

Elective course					
DSE	**Course code: 511501**	**Differential Geometry**	**T**	**Credits:5**	**Hours:5**
Unit -I					
Objective 1	To introduce the concepts -What is a curve? Arc-Length, Curvature, Plane curves, SpaceCurves, Frenet –Serret Equations.				
Introductory remark about space curves – Definitions – Arc length – Tangent, normal and binomial – Curvature and torsion of a curve given as the intersection of two surfaces.					
Outcome1	Understand the curvature and torsion of a space curve, how to compute them, and how theysuffice to determine the shape of the curve.				**K2**
Unit II					
Objective 2	To make the knowledge about Surfaces, Smooth surfaces, Tangents, Normals, Quadric Surfaces.				
Contact between curves and surfaces – Tangent surface, involutes and evolutes – Intrinsicequations – Fundamental existence theorem for space curves – Helices.					
Outcome2	Understand the definition of a smooth surface, and the means by which many examplesmay be constructed.				**K4**
Unit III					
Objective 3	To introduce the concepts of Lengths of Curves on Surfaces, Isometries of Surfaces, Conformal Mappings of Surfaces.				
Definition of a surface – Curves on a surface – Surface of revolution – Helicoids – Metric –Direction coefficients.					
Outcome3	Understand the various different types of curvature associated to a surface, and how tocompute them.				**K3**
Unit IV					
Objective 4	To discuss the concepts of Isometric correspondence, Intrinsic properties and Geodesics				
Families of curves – Isometric correspondence – Intrinsic properties - Geodesics – CanonicalGeodesic equations – Normal property of Geodesics.					
Outcome4	Know about Geodesics, Canonical Geodesic equations and Normal property of Geodesics.				**K5**
Unit V					
Objective 5	To explain the concepts of Gauss Bonnet theorem and Gaussian curvature.				
Existence theorem– Geodesic parallels – Geodesic curvature – Gauss – Bonnet theorem - Gaussiancurvature.					
Outcome5	Acquire knowledge about Existence theorem.				**K6**

Suggested Readings:

Willmore, T.G. (2018). *An Introduction to Differential Geometry*. Twenty Ninth, Oxford University press.

Rao, S.S. (2009). *Engineering Optimization: Theory and Practice* (4th ed.). John Wiley and Sons.Somasundaram, D. (2005). *Differential Geometry*. Chennai: Alpha Science International Ltd.

Struik, D.T. (1950). *Lectures on Classical Differential Geometry*. Addison Wesely, Mass.

Thorpe, J.A. (1979). *Elementary Topics in Differential Geometry*. New York: Springer – Verlag.

Online resources

https://ocw.mit.edu/courses/18-950-differential-geometry-fall-2008/

https://ugcmoocs.inflibnet.ac.in/index.php/courses/view_ug/364

K1-Remember	*K2-Understand*	*K3- Apply*	*K4-Analyze*	*K5-Evaluate*	*K6-Create*

Course Designed by: Dr.N.Anbazhagan

Course Outcome VS Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S(3)	S(3)	S(3)	L(1)	S(3)	M(2)	S(3)	S(3)	S(3)	M(2)
CO2	S(3)	S(3)	M(2)	S(3)	M(2)	S(3)	L(1)	S(3)	S(3)	S(3)
CO3	S(3)	M(2)	S(3)	S(3)	S(3)	S(3)	S(3)	M(2)	S(3)	S(3)
CO4	S(3)	S(3)	S(3)	S(3)	S(3)	L(1)	S(3)	S(3)	M(2)	S(3)
CO5	S(3)	S(3)	S(3)	M(2)	L(1)	S(3)	S(3)	S(3)	S(3)	S(3)
AVG	**3**	**2.8**	**2.8**	**2.4**	**2.4**	**2.4**	**2.6**	**2.8**	**2.8**	**2.8**

S –Strong (3), M-Medium (2), L- Low (1)

Course Outcome VS Programme Specific Outcomes

CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S(3)	S(3)	M(2)	S(3)	L(1)
CO2	S(3)	S(3)	S(3)	S(3)	M(2)
CO3	S(3)	M(2)	S(3)	S(3)	S(3)
CO4	S(3)	S(3)	S(3)	S(3)	M(2)
CO5	S(3)	M(2)	S(3)	L(1)	S(3)
AVG	**3**	**2.6**	**2.8**	**2.6**	**2.2**

S –Strong (3), M-Medium (2), L- Low (1)

Elective Course					
DSE	**Course Code: 511502**	**Theory of Automata and Formal Languages**	**T**	**Credits:5**	**Hours:5**

Unit-1		
Objective 1	Understand the theoretical foundations of automata theory.	
The theory of automata.		
Outcome 1	Understand the basic properties of formal languages and grammar.	**K2**
Unit-2		
Objective 2	Analyze and design different types of automata for computation task.	
Formal languages.		
Outcome 2	Differentiate regular, context-free, and recursively enumerable languages.	**K6**
Unit-3		
Objective 3	Explore the limits of computation and recognize the undecidable problems.	
Regular sets and regular grammar.		
Outcome 3	Make grammars to produce strings from a specific language.	**K4**
Unit-4		
Objective 4	Introduce context-free grammar, parse trees, and push-down automata to understand the structure and syntax of more complex languages.	
Context-free languages.		
Outcome 4	Acquire concepts relating to the theory of computation and computational models including decidability and intractability.	**K2**
Unit-5		
Objective 5	Grasp practical applications of Push-down automata and turing machines for language recognition and computation.	
Push down automata and Turing machines.		
Outcome 5	Prove properties of languages, grammars, and automata with rigorously formal mathematical methods.	**K5**

Suggested Readings:

Linz,P. (2012).*Introduction to Formal Languages and Automata*. Jones and Barlett Learning, LLC.

John Hopcroft,E., Motwani,R., Ullman,J.D. (2011).*Introduction to Automata Theory, Languages and Computation* (3rd ed.).Pearson Education, India.

Mishra,K.L.P., Chandrasekaran,N.(2018).*Theory of Computer Science(Automata, Languages and Computation)* (3rd ed.).,Prentice Hall Of India.

Sipser,M. (2013). *Introduction to the Theory of Computation*. USA: Cengage Learning.

Online resources:

nptel.ac.in

K1-Remember	***K2-Understand***	***K3- Apply***	***K4-Analyze***	***K5-Evaluate***	***K6-Create***

Course designed by: Dr. J. Vimala

Course Outcome VS Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S(3)	L(3)	M(2)	M(2)	M(2)	S(3)	M(2)	S(3)	M(2)	L(1)
CO2	L(1)	M(2)	S(3)	L(1)	M(2)	S(3)	M(2)	M(2)	M(2)	L(1)
CO3	M(2)	M(2)	L(1)	M(2)	L(1)	S(3)	M(2)	L(1)	M(2)	M(2)
CO4	S(3)	M(2)	S(3)	M(2)	M(2)	L(1)	M(2)	M(2)	L(1)	L(1)
CO5	S(3)	S(3)	M(2)	S(3)	M(2)	S(3)	M(2)	M(2)	S(3)	S(3)
AVG	**2.4**	**2.4**	**2.2**	**2**	**1.8**	**2.6**	**2**	**2**	**2**	**1.6**

S-Strong(3), M-Medium(2), L-Low(1)

Course Outcome VS Programme Specific Outcomes

CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M(2)	S(3)	S(3)	M(2)	M(2)
CO2	M(2)	L(1)	M(2)	L(1)	M(2)
CO3	L(1)	M(2)	M(2)	S(3)	L(1)
CO4	M(2)	M(2)	M(2)	M(2)	M(2)
CO5	M(2)	S(3)	L(1)	M(2)	S(3)
AVG	**1.8**	**2.2**	**2**	**2**	**2**

S-Strong(3), M-Medium(2), L-Low(1)

Elective course					
DSE	**Course code: 511503**	**Combinatorics**	**T**	**Credits:5**	**Hours:5**

Unit -I

Objective 1	Make the students familiar with distributions of distinct objects and non distinct objects

Permutations and combinations – Distributions of distinct objects – Distributions of non distinct objects – Stirling's formula.

Outcome1	Understand the concept of distributions of distinct objects and non distinct objects. Also able to understand and find Stirling's formula and its uses.	**K2**

Unit II

Objective 2	Discuss the generating function for combinations, partition of integers and Ferrarey graphs

Generating functions – Generating function for combinations – Enumerators for permutations distributions of distinct objects into non distinct cells – partitions of integers – Ferrers graphs – Elementary relations- The Exponential Generating functions-The summation operator.

Outcome2	Apply the generating function for combinations, partition of integers and Ferrarey graphs inreal life problems.	**K3**

Unit III

Objective 3	Formulate linear and non linear recurrence relations to solve problems

Recurrence relation – Linear recurrence relations with constant coefficients- The nonhomogeneous recurrence relation- solutions by the technique of generating functions – A special class ofnonlinear difference equations – Recurrence relations with two indices

Outcome3	Use linear and non linear recurrence relations to solve problems.	**K3**

Unit IV

Objective 4	Analyse the principle of inclusion and exclusion with permutations, derangements and Rook polynomials

The principle of inclusion and exclusion – General formula – Permutations with restriction on relative positions – Derangements – Rook polynomials – permutations with forbidden positions

Outcome4	Analyse and how to use the principle of inclusion and exclusion with permutations,derangements and Rook polynomials in various applications.	**K4**

Unit V

Objective 5	Explain about Polya's theory of counting using Burnside theorem, Equivalence classes of functions, Polya's fundamental and generalization theorem

Polya's theory of counting – Equivalence classes under a permutation group – Burnside theorem – Equivalence classes of functions – Weights and inventories of functions – Polya's fundamental theorem – Generalization of Polya's theorem

Outcome5	Understand Polya's theory of counting using Burnside theorem, Equivalence classes of functions, Polya's fundamental and generalization theorem, and their applications.	**K5**

Suggested Readings:

Ralph P.Grimaldi., Ramana B.V.(2009) *Discrete and Combinatorial Mathematics- An applied introduction*.(5th Edition) Pearson Education, Dorling Kindersley(India) Pvt.Ltd.

Cameron, P.J. (1998). *Combinatorics: Topics, Techniques, Algorithms*. Cambridge: Cambridge University Press.

Liu, C.L., Eddberg, M. (1968). *Solutions to problems in Introduction to Combinatorial mathematics*. New York: MCGraw-Hill Book & Co.

Liu, C.L. (1968). *Introduction of Combinatorial Mathematics*. New York: McGraw Hill Book Co.

Stanley, R.P. (1997). *Enumerative Combinatorics*, Volume I, Cambridge Studies in Advanced Mathematics, Volume 49. Cambridge University Press.

J.H. Van Lint, R.M. Wilson, *A Course in Combinatorics*, 2nd Edition, Cambridge University Press, Cambridge, 2001.

Online resources

1. https://ocw.mit.edu/courses/18-212-algebraic-combinatorics-spring-2019/
2. https://onlinecourses.nptel.ac.in/noc23_ma19/preview

K1-Remember	*K2-Understand*	*K3- Apply*	*K4-Analyze*	*K5-Evaluate*	*K6-Create*

Course Designed by: Dr.M.Mullai

Course Outcome VS Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M(2)	M(2)	S(3)	M(2)	L(1)	M(2)	M(2)	S(3)	S(3)	L(1)
CO2	S(3)	S(3)	S(3)	M(2)	L(1)	M(2)	S(3)	M(2)	M(2)	S(3)
CO3	M(2)	M(2)	L(1)	S(3)	S(3)	M(2)	L(1)	M(2)	S(3)	M(2)
CO4	M(2)	L(1)	L(1)	S(3)	M(2)	M(2)	M(2)	S(3)	M(2)	S(3)
CO5	L(1)	S(3)	M(2)	M(2)	S(3)	S(3)	M(2)	S(3)	S(3)	L(1)
AVG	**2**	**2.2**	**2**	**2.4**	**2**	**2.2**	**2**	**2.6**	**2.4**	**2**

S –Strong (3), M-Medium (2), L- Low (1)

Course Outcome VS Programme Specific Outcomes

CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M(2)	M(2)	S(3)	L(1)	S(3)
CO2	S(3)	L(1)	S(2)	M(2)	M(2)
CO3	L(1)	M(2)	M(2)	S(3)	S(3)
CO4	S(3)	M(2)	L(1)	M(2)	M(2)
CO5	L(1)	S(3)	S(3)	M(2)	S(3)
AVG	**2**	**2**	**2.2**	**2**	**2.6**

S –Strong (3), M-Medium (2), L- Low (1)

Elective Course					
DSE	**Course Code: 511504**	**Fluid Dynamics**	**T**	**Credits: 5**	**Hours: 5**

Unit –I

Objective 1	To understand the real and ideal fluids which are two different extreme flows to each other, and they can differ from one another based on the viscosity.	
Real fluids and ideal fluids – Velocity – Streamlines – Steady and unsteady flows – Velocity potential.		
Outcome 1	Identify the differences between the real and ideal fluids and apply the notion of viscosity to each and every fluid around us like water, diesel, petrol etc.,	**K2**

Unit II

Objective 2	Learning vorticity is an important quantity in the dynamical theory of fluids and provides a convenient framework for understanding a variety of complex flow phenomena, such as the formation and motion of vortex rings	
Vorticity vector – Equation of continuity – Euler's equation of motion – Bernouli's equation – Some three-dimensional flows – Impulsive motion.		
Outcome 2	Learn the notion of the Bernoulli equation to solve problems in fluid mechanics and control volume analysis to problems in fluid mechanics.	**K3**

Unit III

Objective 3	The students will be able to know that the stream function can be used to plot streamlines, which represent the trajectories of particles in a steady flow	
Sources – Doubles – Images in a rigid infinite plane – Images in solid spheres – Anti symmetric flows.		
Outcome 3	Knowing the concepts of incompressible fluid flow in an asymmetric channel with absorbing walls, students be able to identify the flows in renal tubules	**K4**

Unit IV

Objective 4	To understand and use the differential equations to determine pressure and velocity variations in internal and external flows	
Irrotational motions – Use of cylindrical polar coordinates – Stream functions – Complex potential for two dimensional, irrotational and incompressible flow.		
Outcome 4	Having the knowledge of irrotational flow, students can be able to identify the study of blood flow in the human body and to predict the velocity, pressure, and flow rate of blood in the human circulatory system.	**K5**

Unit V

Objective 5	To develop an understanding of fluid dynamics in aerospace engineering as well as a variety of other fields	
Irrotational incompressible flow – Complex velocity potentials for standard two-dimensional flows – Systems of conformal transformation - the Milline Thomson Circle theorem - Some applications of the circle theorem – The theorem of Blasius – The use of Conformal transformation.		
Outcome 5	Obtain some applications of canonical transformation theory to the analysis of optimal trajectories for space vehicles	**K5**

Suggested Readings:

Chorlton, F. (1985). *Text Book of Fluid Dynamics*. New Delhi: CBS Publications.

Batchaelor, G.K. (2005). *An Introduction to Fluid Dynamics*. New Delhi: Foundation Books.

Rathy, R.K. (1976). *An Introduction to Fluid Dynamics*. New Delhi: IBH Publ. Comp.

Yuan, S.W. (1976). *Foundations of Fluid Mechanics*. New Delhi: Prentice Hall of India Pvt. Ltd.

Online resources

https://onlinecourses.nptel.ac.in/noc21_me126/preview

https://ocw.mit.edu/courses/2-06-fluid-dynamics-spring-2013/

https://www.coursera.org/learn/applied-computational-fluid-dynamics

K1-Remember	*K2-Understand*	*K3- Apply*	*K4-Analyze*	*K5-Evaluate*	*K6-Create*

Course Designed by: Dr.R.RAJA

Course Outcome VS Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S (3)	M (2)	S (3)	S (3)	M (2)	L (1)	M (2)	L (1)	M (2)	S (3)
CO2	S (3)	M (2)	M (2)	M (2)	L (1)	L (1)	M (2)	L (1)	L (1)	S (3)
CO3	M (2)	M (2)	S (3)	S (3)	M (2)	L (1)	L (1)	L (1)	L (1)	S (3)
CO4	M (2)	M (2)	S (3)	S (3)	L (1)	L (1)	M (2)	L (1)	L (1)	S (3)
CO5	S (3)	M (2)	S (3)	S (3)	M (2)	L (1)	M (2)	L (1)	L (1)	S (3)
W.AV	**2.6**	**2.0**	**2.4**	**2.4**	**1.6**	**1.0**	**1.4**	**1.0**	**1.2**	**3.0**

S –Strong (3), M-Medium (2), L- Low (1)

Course Outcome VS Programme Specific Outcomes

CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M (2)	M (2)	M (2)	M (2)	M (2)
CO2	S (3)	S (3)	S (3)	S (3)	S (3)
CO3	S (3)	S (3)	S (3)	S (3)	S (3)
CO4	M (2)	M (2)	M (2)	M (2)	M (2)
CO5	L (1)	L (1)	L (1)	L (1)	L (1)
W.AV	**2.2**	**2.2**	**2.2**	**2.2**	**2.2**

S –Strong (3), M-Medium (2), L- Low (1)

Elective course					
DSE	**Course code: 511505**	**Object Oriented Programming and C++**	**T**	**Credits:5**	**Hours:5**

Unit -I

Objective 1	To understand how C++ improves C with object-oriented features.

Introduction: Differences Between C And C++, Advantages of OOP, Structure of A C++ Program, Principles – Basic concepts – Benefits – Languages of OOP- Variable Declaration and Initialization, Data Types, Operators in C and C++- – Cin and Cout streams – Manipulators – Control Loop Statements and Functions.

Outcome1	Able to understand and design the solution to a problem using object-oriented programming concepts.	**K1**

Unit II

Objective 2	To understand the concept of data abstraction and encapsulation, inheritance and virtual functions implement dynamic binding with polymorphism.

Object and classes: Introduction, class specification, class objects, accessing class members, defining member functions, accessing member functions within a class, outside member functions - Constructor and destructor – Inline function – Friend function – Static data and member function.

Outcome2	Understand and implement the features of C++ including inheritance and polymorphism programmed solutions to complex problems	**K3**

Unit III

Objective 3	To learn the syntax and semantics of the C++ programming language

Pointers: Pointers and references – This pointer – Strings – New and delete operators -Dynamic constructors – Problems with pointer reference Copy constructor.

Outcome3	Able to understand pointer and its operations	**K2**

Unit IV

Objective 4	To learn how to design and implement operator & function overloading

Polymorphism: Compile time polymorphism – Function overloading – Operator overloading – Overloading unary operators – Overloading binary operators.

Outcome4	Understanding the difference between function overloading &operator overloading	**K3**

Unit V

Objective 5	To learn how to design C++ classes for code reuse.

Inheritance: introduction to Inheritance – Derived class - Types of inheritance – Inheritance access specifier – Virtual function – Pure virtual function.

Outcome 5	Apply virtual and pure virtual function and difficult programming situations	**K4**

Suggested Readings:

Balagurusamy, E. (2018). Object oriented programming in C++ (7th ed.). Tata McGraw Hill publications Ltd.

Ashok Kamthane.N, 2013,*Programming In C++*, 2nd Edition, Pearson education,

Bjarne Stroustrup, 2013, "*The C++ Programming Language*", Fourth Edition, Addison Wesley.

Rajaram.R, 2013.*Object Oriented Programming in C++,* Fifth Edition, New Age International Publishers, New Delhi.

Robe Lafore,2012, *Object Oriented Programming in C++,* Fourth Edition, Galgotia Publications Pvt. Ltd., New Delhi

Online resources:

https://ocw.mit.edu/courses/6-096-introduction-to-c-january-iap-2011/
https://onlinecourses.nptel.ac.in/noc21_cs02/preview

K1-Remember	*K2-Understand*	*K3- Apply*	*K4-Analyze*	*K5-Evaluate*	*K6-Create*

Course Designed by: Dr. A. Nagarajan

Course Outcome VS Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M(2)	M(2)	M(2)	L(1)	L(1)	L(1)	M(2)	S(3)	L(1)	L(1)
CO2	M(2)	S(3)	M(2)	L(1)	M(2)	M(2)	S(3)	S(3)	M(2)	L(1)
CO3	L(1)	M(2)	S(3)	S(3)	L(1)	L(1)	M(2)	L(1)	L(1)	L(1)
CO4	L(1)	L(1)	M(2)	M(2)	L(1)	M(2)	L(1)	M(2)	L(1)	L(1)
CO5	L(1)	M(2)	L(1)	L(1)	L(1)	L(1)	L(1)	L(1)	L(1)	M(2)
W.AV	**1.4**	**2**	**2**	**1.6**	**1.2**	**1.4**	**1.8**	**2**	**1.2**	**1.2**

S –Strong (3), M-Medium (2), L- Low (1)

Course Outcome VS Programme Specific Outcomes

CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S(3)	M(2)	M(2)	L(1)	M(2)
CO2	M(2)	S(3)	S(3)	L(1)	L(1)
CO3	M(2)	L(1)	M(2)	M(2)	L(1)
CO4	L(1)	L(1)	L(1)	M(2)	L(1)
CO5	L(1)	L(1)	L(1)	L(1)	L(1)
W.AV	**1.8**	**1.6**	**1.8**	**1.4**	**1.2**

S –Strong (3), M-Medium (2), L- Low (1)

Elective Course					
DSE	**Course code: 511506**	**Skills in Latex**	**T**	**Credits:5**	**Hours:5**

Unit –I		
Objective 1	To learn the basic functions of Latex and to explore some of the more advanced featuresavailable.	
Introduction: Text formatting, TEX and its offspring, **Text, Symbols and Commands:** Command names and arguments – Environments- Declarations – Lengths – Special characters-spaces and carriage returns –quotation marks- hyphens and dashes-printing command characters.		
Outcome1	Understand basic concepts of Text formatting and latex file.	**K1**
Unit II		
Objective 2	To develop their skills in order to fully utilize its functions in particular using Bibtex to helpmanage their references in relation to the Latex document.	
Document Layout and Organization: Document class – Page style – Parts of the document – Table of contents-Automatic entries, printing the table of contents-Fine-Tuning text-Line breaking, Page breaking.		
Outcome2	Use the preamble of LaTeX file to define document class and layout options.	**K2**
Unit III		
Objective 3	To acquire the knowledge how to include the main title of the document	
Displayed Text: Changing font – Centering and indenting - Lists - Generalized lists – Theorem likedeclarations – Tabulator stops.		
Outcome3	Use nested list and enumerate environments within a document.	**K3**
Unit IV		
Objective 4	To learn the basic ideas of how to draw Vertical and horizontal lines of tables	
Displayed Text: Boxes -Tables – Printing literal text - Footnotes and marginal notes – Commentswithin text.		
Outcome4	Use tabular and array environments within LaTeX document.	**K5**
Unit V		
Objective 5	To acquire the basic ideas of how to include external packages in mathematics within text and usage of Mathematical equations.	
Mathematical Formulas: Mathematical environments - Main elements of Math mode - Mathematical symbols – Additional elements – Fine tuning Mathematics–Horizantal spacing, selecting font size in formulas.		
Outcome5	Use various methods to either create or import graphics into a LaTeX document. Acquire the importance of the type settings in Mathematical equation.	**K5**

Suggested Readings:

Kopka, H., Daly, P.W. (2003). *A Guide to LATEX*, Fourth Edition, London: Addision Wesley.

Kottwitz, S. (2011). *Latex Beginners Guide*. Packt publishing.

Lamport, L. (1994). *Latex: A document preparation system*. Addison Wesley Professional.

Mittelbach, F. (2007). *The Latex Graphics Companion* (2nd ed.). Addison-Wesley professional.

Online resources:

https://www.overleaf.com/learn/latex/Learn_LaTeX_in_30_minutes

https://www.overleaf.com/learn/latex/Free_online_introduction_to_LaTeX_(part_1)

K1-Remember	*K2-Understand*	*K3- Apply*	*K4-Analyze*	*K5-Evaluate*	*K6-Create*

Course Designed by: Dr. R. Jeyabalan

Course Outcome VS Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S(3)	M(2)	S(3)	M(2)	S(3)	S(3)	S(3)	M(2)	S(3)	S(3)
CO2	M(2)	L(1)	S(3)	L(1)	S(3)	S(3)	S(3)	M(2)	S(3)	S(3)
CO3	S(3)	M(2)	S(3)	M(2)	S(3)	S(3)	S(3)	L(1)	S(3)	S(3)
CO4	L(1)	M(2)	S(3)	M(2)	S(3)	S(3)	S(3)	M(2)	S(3)	S(3)
CO5	S(3)	M(2)	M(2)	S(3)	S(3)	S(3)	M(2)	S(3)	S(3)	S(3)
AVG	**2.4**	**1.8**	**2.8**	**2**	**3**	**3**	**2.8**	**2**	**3**	**3**

S –Strong (3), M-Medium (2), L- Low (1)

Course Outcome VS Programme Specific Outcomes

CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S(3)	S(3)	L(1)	M(2)	L(1)
CO2	S(3)	S(3)	L(1)	M(2)	L(1)
CO3	S(3)	S(3)	L(1)	M(2)	L(1)
CO4	S(3)	S(3)	L(1)	M(2)	L(1)
CO5	S(3)	S(3)	L(1)	M(2)	L(1)
AVG	**3**	**3**	**1**	**2**	**1**

S –Strong (3), M-Medium (2), L- Low (1)

II - Semester					
Core	**Course code: 511201**	**Linear Algebra**	**T**	**Credits:5**	**Hours:6**

Unit-1

Objective 1	Describe the fundamental notions of vector spaces, subspaces, bases, dimensions, coordinates, and the Summary of Row-Equivalence.

Vector spaces-Subspaces-Bases and dimension-Coordinates-Summary of row-equivalence-Computations concerning subspaces

Outcome 1	Demonstrate understanding of the concepts of vector space and subspace.	**K1**

Unit-2

Objective 2	Learn about linear transformation on n-dimensional vector spaces.

Linear transformations- The algebra of linear transformations– Isomorphisms - Representation of transformations by matrices - Linear functionals - The double dual - The transpose of a linear transformation.

Outcome 2	Solve systems of linear equations using multiple methods, including Gaussian elimination and matrix inversion.	**K4**

Unit-3

Objective 3	Establish some of the fundamental algebraic properties of a polynomial over a field.

Polynomials: Algebras-Thealgebraofpolynomials-Lagrangeinterpolation-Polynomialideals-Theprime factorization of a polynomial.

Outcome 3	Demonstrate understanding of linear independence, span, and basis.	**K5**

Unit-4

Objective 4	Define the concepts of commutative rings and invariant subspaces.

Determinants: Commutative rings - Determinant functions - Permutations and the uniqueness of determinants - Additional properties of determinants Elementary Canonical Forms: Introduction -Characteristic values-Annihilating polynomials.

Outcome 4	Apply principles of matrix algebra to linear transformations.	**K3**

Unit-5

Objective 5	Study the direct-sum decompositions and invariant direct sums

Invariant subspaces-Simultaneoustriangulation:Simultaneous diagonalization-Direct-sum Decompositions -Invariant direct sums-The primary decomposition theorem.

Outcome 5	Demonstrate understanding of inner products and associated norms.	**K5**

Suggested Readings:

Hoffman,K.,Kunze,R.(2015). *Linear Algebra*(2nd ed.).Pearson Education Inc., Prentice Hall Sons.

Artin,M.(1991).*Algebra*.New Delhi: Prentice Hall of India.

David Lay, C. (2003). *Linear Algebra and its Applications* (3rd ed.). Pearson Education, Inc..Lang,S. (1971).*Algebra*(3rd ed.). Addison-Wesley, Reading, MA.

Strang,G.(2009).*IntroductiontoLinearAlgebra*(4thed.).WellesleyCambridgePress.

Online resources:

nptel.ac.in

khanacademy.org/math/linear-algebra

K1-Remember	*K2-Understand*	*K3- Apply*	*K4-Analyze*	*K5-Evaluate*	*K6-Create*

Course designed by: Dr. J. Vimala

Course Outcome VS Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	L(1)	M(2)	M(2)	M(2)	M(2)	S(3)	L(1)	S(3)	L(1)	M(2)
CO2	L(1)	M(2)	S(3)	L(1)	M(2)	M(2)	M(2)	M(2)	M(2)	L(1)
CO3	M(2)	M(2)	L(1)	M(2)	S(3)	S(3)	M(2)	S(3)	M(2)	M(2)
CO4	S(3)	M(2)	S(3)	S(3)	M(2)	S(3)	M(2)	M(2)	L(1)	L(1)
CO5	L(1)	L(1)	S(3)	S(3)	M(2)	S(3)	M(2)	M(2)	S(3)	L(1)
AVG	**1.6**	**1.8**	**2.4**	**2.2**	**2.2**	**2.8**	**1.8**	**2.4**	**1.8**	**1.4**

S-Strong(3), M-Medium(2), L-Low(1)

Course Outcome VS Programme Specific Outcomes

CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S(3)	S(3)	L(1)	M(2)	M(2)
CO2	M(2)	L(1)	M(2)	L(1)	M(2)
CO3	L(1)	M(2)	M(2)	M(2)	M(2)
CO4	M(2)	L(1)	M(2)	L(1)	M(2)
CO5	L(1)	S(3)	M(2)	S(3)	L(1)
AVG	**1.8**	**2**	**1.8**	**1.8**	**1.8**

S-Strong(3), M-Medium(2), L-Low(1)

II - Semester					
Core	**Course code: 511202**	**Real Analysis-II**	**T**	**Credits:5**	**Hours:6**
Unit -I					
Objective 1	Focus on the definition of Riemann-Stieltjes integration				
The Riemann – Stieltjes integral: Definition and existence of the integral - Properties of the integral – Integration and differentiation – Integration of vector – valued functions – Rectifiable curves.					
Outcome1	Learners understand the Riemann-Stieltjes integration better.				**K2**
Unit II					
Objective 2	Introducing different types of applications of sequences and series of functions.				
Sequences and series of functions: Discussion on main problem – Uniform convergence – Uniformconvergence and continuity – Uniform convergence and integration					
Outcome2	Know the basic theory of sequences and series of functions with applications.				**K3**
Unit III					
Objective 3	Aim to introduce Weierstrass theorem				
Sequences and series of functions (Conti): Uniform convergence and differentiation – Equicontinuous families of functions – Weierstrass theorem					
Outcome3	Understand the proof of Weierstrass theorem.				**K4**
Unit IV					
Objective 4	To investigate the exponential and logarithmic relations				
Some special functions: Power series – The exponential and logarithmic functions – Thetrigonometric functions.					
Outcome4	Consolidate earlier knowledge of exponential and logarithmic relations through applications.				**K5**
Unit V					
Objective 5	To illustrate how general methods of Gamma function can be used				
The algebraic completeness of the complex field – Fourier series – The gamma function					
Outcome5	Understand the applications of Gamma function.				**K5**

Suggested Readings:

Walter Rudin, (2016). *Principles of Mathematical Analysis* (3rd ed.). New York: McGraw-Hill.

Apostol, T.M. (1985). *Mathematical Analysis* (2nd ed.). New Delhi: Narosa Publ.

House.Ganapathy Iyer, V. (1970). *Mathematical Analysis*. New Delhi: Tata McGraw

Hill.

Royden, H.L. (1993). *Real Analysis* (4th ed.). New York: Macmillan Publ. Co. Inc.

Russel Gorden, A. (2011). *Real Analysis*. A First Course, Pearson.

Online resources: http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics, http://www.opensource.org, www.mathpages.com

K1-Remember	*K2-Understand*	*K3- Apply*	*K4-Analyze*	*K5-Evaluate*	*K6-Create*

Course Designed by: Dr. B. Sundaravadivoo

Course Outcome VS Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	L(1)	M(2)	M(2)	M(2)	S(3)	M(2)	S(3)	M(2)	M(2)	L(1)
CO2	L(1)	M(2)	S(3)	M(2)	S(3)	S(3)	S(3)	M(2)	S(3)	L(1)
CO3	S(3)	L(1)	S(3)	M(2)	S(3)	S(3)	S(3)	M(2)	M(2)	S(3)
CO4	L(1)	M(2)	S(3)	S(3)	S(3)	M(2)	S(3)	M(2)	M(2)	L(1)
CO5	M(2)	L(1)	S(3)	S(3)	S(3)	M(2)	S(3)	M(2)	S(3)	M(2)
AVG	**1.6**	**1.6**	**2.7**	**2.4**	**3**	**2.4**	**3**	**2**	**2.4**	**1.6**

S –Strong (3), M-Medium (2), L- Low (1)

Course Outcome VS Programme Specific Outcomes

CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	L(1)	M(2)	M(2)	M(2)	S(3)
CO2	L(1)	M(2)	S(3)	M(2)	S(3)
CO3	L(1)	M(2)	M(2)	M(2)	S(3)
CO4	L(1)	M(2)	M(2)	S(3)	S(3)
CO5	M(2)	S(3)	S(3)	S(3)	S(3)
AVG	**1.2**	**2.2**	**2.4**	**2.4**	**3**

S –Strong (3), M-Medium (2), L- Low (1)

II - Semester					
Core	**Course code: 511203**	**Complex Analysis**	**T**	**Credits:5**	**Hours:5**

Unit -I

Objective 1	The concepts of Analysis, Cauchy-Riemann relations and harmonic functions are then introduced.

Analytic functions– Polynomials – Rational functions – Power series – Abel's limit theorem – Bi-linear transformations.

Outcome1	Apply the fundamental concepts of complex numbers and variables.	**K1**

Unit II

Objective 2	The notion of the Riemann sheet is presented to help the student to visualize multi-valued complex functions. Complex integration and complex power series are presented. Students will be equipped with the understanding of the fundamental concepts of complex variable theory.

Complex integration - line integrals - Fundamental theorems– Cauchy's theorem for rectangle- Cauchy's theorem for disk - Cauchy's integral formula – index of a point with respect to a closed curve, Higher derivatives.

Outcome2	Solve the problem using Cauchy's integral formula and Cauchy's residue theorem, Residuetheorem.	**K2**

Unit III

Objective 3	The skill of contour integration to evaluate complicated real integrals via residue calculus.

Local properties of analytic functions: Removable singularities, Taylor's theorem, zeroes andpoles, the local mapping, maximum principle, the general form of Cauchy's theorem.

Outcome3	Formulate and solve differential equation problem in the field of industrial organizationengineering.	**K4**

Unit IV

Objective 4	Study the concept of residue theorem and the evaluation of definite integrals.

The calculus of residues: The residue theorem – The argument principle – Evaluation of definiteintegrals.

Outcome 4	Know the tool to evaluate line integrals of analytic functions.	**K5**

Unit V

Objective 5	Express analytic functions as infinite series.

Weierstrasstheorem, Taylor's series, Laurent series.

Outcome 5	Work around the singularities of the complex function.	**K6**

Suggested Readings:

Lars Ahlfors, V. (2016). *Complex Analysis* (3rd ed.)., McGraw Hill.

Conway, J.B. (1980). *Functions of one Complex variable*. New Delhi: Narosa Publ.

House.Lang, S. (1977). *Complex-Analysis*. Addison Wesley Mass.

McMullen, C. (1893). *Complex Analysis*. USA: Harvard University.

Ponnusamy, S. (2004). *Foundations of Complex Analysis*. New Delhi: Narosa Publ. House.Stein and Shakarchi, (2003). *Complex Analysis.* Princeton University Press.

Online resources:

https://archive.nptel.ac.in/courses/111/106/111106141

https://www.coursera.org/learn/complex-analysis

K1-Remember	***K2-Understand***	***K3- Apply***	***K4-Analyze***	***K5-Evaluate***	***K6-Create***

Course Designed by: Dr. R. Jeyabalan

Course Outcome VS Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S(3)	M(2)	S(3)	M(2)	S(3)	S(3)	S(3)	M(2)	S(3)	S(3)
CO2	M(2)	L(1)	S(3)	L(1)	S(3)	S(3)	S(3)	M(2)	S(3)	S(3)
CO3	S(3)	M(2)	S(3)	M(2)	S(3)	S(3)	S(3)	L(1)	S(3)	S(3)
CO4	L(1)	M(2)	S(3)	M(2)	S(3)	S(3)	S(3)	M(2)	S(3)	S(3)
CO5	S(3)	M(2)	M(2)	S(3)	S(3)	S(3)	M(2)	S(3)	S(3)	S(3)
AVG	**2.4**	**1.8**	**2.8**	**2**	**3**	**3**	**2.8**	**2**	**3**	**3**

S –Strong (3), M-Medium (2), L- Low (1)

Course Outcome VS Programme Specific Outcomes

CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S(3)	S(3)	L(1)	M(2)	L(1)
CO2	S(3)	S(3)	L(1)	M(2)	L(1)
CO3	S(3)	S(3)	L(1)	M(2)	L(1)
CO4	S(3)	S(3)	L(1)	M(2)	L(1)
CO5	S(3)	S(3)	L(1)	M(2)	L(1)
AVG	**3**	**3**	**1**	**2**	**1**

S –Strong (3), M-Medium (2), L- Low (1)

II - Semester					
Core	**Course code: 511204**	**Partial Differential Equations**	**T**	**Credits: 5**	**Hours:5**

Unit I

Objective 1	Introduce the notion of partial differential equations.	
Ordinary differential equations in more than two variables: Surfaces and curves in three dimensions-Simultaneous differential equations of the first order and the first degree in three variables-Methods of solution of dx/P=dy/Q=dz/R orthogonal trajectories of a system of curves on a surface-Pfaffian differential forms and equations-Solution of Pfaffian differential equations in three variables.		
Outcome1	Classify partial differential equations and transform into canonical form.	**K2**

Unit II

Objective 2	Introduce the students to how to solve linear partial differential equations with differentmethods.	
Partial differential equations of the first order: Partial differential equations-Origins of first order partial differential equations-Cauchy's problem for first order equations-Linear equations of the first order-Integral surfaces passing through a given curve-Surfaces orthogonal to a given system of surfaces-Nonlinear partial differential equations of the first order-Cauchy's method of characteristics.		
Outcome2	Solve linear partial differential equations of both first and second order.	**K5**

Unit III

Objective 3	Introduce some physical problems in Engineering and Biological models that results inpartial differential equations.	
Compatible systems of first order equations-Charpit's method-Special types of first order equations-Solutions satisfying given conditions-Jacobi's method.		
Outcome3	Students can apply the concept of linearity to solve non-homogeneous PDEs by the methodof linear superposition.	**K3**

Unit IV

Objective 4	Students will gain a deeper understanding of the linear partial differential equations withboth variable and constant co-efficient.	
Partial differential equations of the second order: Origin of second order Equations-Linear partial differential equations with constant coefficients. Equations with variable coefficients-Separation of variables - Method of integral transforms (exercise problems are excluded).		
Outcome4	Students can write down the complete solution of a linear homogeneous wave, heat or Laplace's equation on a rectangular or rotationally-symmetric domain using separation of variables.	**K4**

Unit V

Objective 5	Students will learn the separation of variables method to solve linear parabolic, elliptic and hyperbolic partial differential equations	
Laplace's equation: Elementary solutions of Laplace's equation-boundary value problems - The Wave equation: Elementary solutions of the one dimensional wave equation - The Diffusion equation: Elementary solutions of the diffusion equation-separation of variables.		
Outcome5	Students can prove orthogonality and uniqueness of solutions to a boundary value problem.	**K6**

Suggested Readings:

Sneddon. (1986). *Elements of Partial Differential Equations* - McGraw Hill Book Company.

S.G. Deo, V. Raghavendra, R. Kar and V. Lakshmikantham. (1980). *Textbook of Ordinary Differential Equations*,Mc Graw Hill Education Private Limited.

W.Y. Loi. (2015). *Ordinary Differential Equations*, National University of Singapore, Singapore.

J.N. Sharma and K. Singh. (2001). *Partial Differential Equation for Engineers and Scientist*, Narosa publ. House,Chennai.

K. Sankar Rao. (1995). *Introduction to partial Differential Equations*, Prentice Hall of India, New Delhi.

S.J. Farlow. (1982). *Partial Differential Equations for Scientists and Engineers*, John Wiley sons, New York.

Online resources					
https://ocw.mit.edu/courses/18-152-introduction-to-partial-differential-equations-fall-2011/					
https://onlinecourses.swayam2.ac.in/cec20_ma08/preview					
K1-Remember	***K2-Understand***	***K3- Apply***	***K4-Analyze***	***K5-Evaluate***	***K6-Create***
Course Designed by: Dr.R.Raja					

Course Outcome VS Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S(3)	M(2)	S(3)	S(3)	S(3)	S(3)	M(2)	S(3)	S(3)	S(3)
CO2	S(3)	L(1)	M(2)	S(3)	S(3)	S(3)	S(3)	M(2)	S(3)	S(3)
CO3	S(3)	M(2)	S(3)	S(3)	S(3)	S(3)	S(3)	S(3)	M(2)	S(3)
CO4	S(3)	S(3)	M(2)	S(3)	S(3)	S(3)	S(3)	S(3)	L(1)	M(2)
CO5	M(2)	S(3)	L(1)	S(3)	S(3)	S(3)	M(2)	S(3)	S(3)	S(3)
AVG	**2.8**	**2.2**	**2.2**	**3**	**3**	**3**	**2.6**	**2.8**	**2.4**	**2.8**

S –Strong (3), M-Medium (2), L- Low (1)

Course Outcome VS Programme Specific Outcomes

CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S(3)	M(2)	S(3)	S(3)	S(3)
CO2	S(3)	S(3)	S(3)	M(2)	S(3)
CO3	S(3)	S(3)	S(3)	S(3)	S(3)
CO4	M(2)	L(1)	S(3)	S(3)	S(3)
CO5	S(3)	S(3)	L(1)	S(3)	M(2)
AVG	**2.8**	**2.4**	**2.6**	**2.8**	**2.8**

S –Strong (3), M-Medium (2), L- Low (1)

Elective Course					
DSE	**Course code: 511507**	**Numerical Analysis**	**T**	**Credits:5**	**Hours: 5**

Unit -I

Objective 1	Derive appropriate numerical methods to interpolating polynomials and divided differences.	
Interpolation by Polynomial: Polynomial Forms - Existence and Uniqueness of the InterpolatingPolynomial-The Divided-Difference Table-The Error of the Interpolating polynomial		
Outcome1	Understanding the theoretical and practical aspects of the use of interpolating polynomials.	**K2**

Unit II

Objective 2	Develop appropriate numerical methods to solve a uniform approximation by polynomials and to derive the methods to evaluate data fitting.	
Approximation: Uniform approximation by polynomials – Data fitting – Orthogonal polynomials – Least square approximation by polynomials.		
Outcome2	Implementing numerical methods for a variety of multidisciplinary applications ofapproximation.	**K3**

Unit III

Objective 3	Derive appropriate numerical methods to solve numerical differentiation and integration.	
Differentiation and Integration: Numerical Differentiation – Numerical Integration: Some Basic Rules – Numerical integration: Gaussian Rules – Numerical Integration: Composite Rules.		
Outcome3	Establishing the limitations, advantages, and disadvantages of numerical differentiation and integration.	**K4**

Unit IV

Objective 4	Perform an error analysis for various numerical methods.	
The solution of Differential equations: Mathematical preliminaries – simple Difference Equations – Numerical integration by Taylor series – Error estimates and convergence of Euler's method –Runge – Kutta methods.		
Outcome4	Understanding of common numerical methods and how they are used to obtain approximatesolutions by using difference equation.	**K5**

Unit V

Objective 5	Derive appropriate numerical methods to calculate multistep formulas	
Multi- step formulas – Predictor – Corrector methods – Boundary value Problems**:** Finite difference methods – Shooting methods.		
Outcome5	Understanding the concept of Predictor and corrector methods and Boundary value problems.	**K6**

Suggested Readings:

Samuel. D. Conte/Carl de Boor, (2011). *Elementary Numerical Analysis: An Algorithmic Approach* (3rd ed.). TATAMcGraw – Hill, New Delhi.

Gerald, C.F., Wheathy, P.O. (1998). *Applied Numerical Analysis*. (5th ed.). Addison Wesley.

Kandasamy, P., Thilagavathy, K., Gunavathy, K. (2003). *Numerical Methods*. S. Chand & Company.Sastry, S. S. (1995). *Introductory methods of Numerical Analysis*. Prentice of India.

Vedamurthy, V.N., Iyengar, Ch. S.N. (1998). *Numerical Methods*. Vikas Publishing House Pvt Ltd.

Online resources

https://onlinecourses.nptel.ac.in/noc23_ma94/preview

https://ocw.mit.e/du/couses/18-335j-introduction-to-numerical-methods-spring-2019/

https://onlinecourses.nptel.ac.in/noc19_ma21/preview

K1-Remember	*K2-Understand*	*K3- Apply*	*K4-Analyze*	*K5-Evaluate*	*K6-Create*

Course Designed by: Dr.S.Amutha

Course Outcome VS Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S(3)	L(1)	M(2)	M(2)	S(3)	S(3)	S(3)	M(2)	S(3)	S(3)
CO2	L(1)	L(1)	S(3)	L(1)	S(3)	S(3)	S(3)	L(1)	S(3)	S(3)
CO3	M(2)	M(2)	S(3)	L(1)	S(3)	S(3)	S(3)	L(1)	S(3)	S(3)
CO4	L(1)	M(2)	S(3)	M(2)	S(3)	M(2)	M(2)	M(2)	S(3)	S(3)
CO5	S(3)	L(1)	M(2)	S(3)	S(3)	S(3)	M(2)	S(3)	S(3)	S(3)
AVG	**2**	**1.4**	**2.6**	**1.8**	**3**	**2.8**	**2.6**	**1.8**	**3**	**3**

S- Strong (3), M- Medium(2), L-Low(1)

Course Outcome VS Programme Specific Outcomes

CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S(3)	S(3)	L(1)	M(2)	L(1)
CO2	S(3)	S(3)	L(1)	M(2)	L(1)
CO3	S(3)	S(3)	L(1)	M(2)	L(1)
CO4	S(3)	S(3)	L(1)	M(2)	L(1)
CO5	S(3)	S(3)	L(1)	M(2)	L(1)
AVG	**3**	**3**	**1**	**2**	**1**

S- Strong (3), M- Medium(2), L-Low(1)

Elective Course					
DSE	**CourseCode: 511508**	**Multivariate Calculus**	**T**	**Credits:5**	**Hours:5**

Unit -I		
Objective 1	Focus on the definition of differentiability with multi variable	
Linear Transformations- Matrices-Differentiation – Partial derivatives – Directional derivatives – Contraction principle – Inverse function theorem.		
Outcome1	Understand better the definition of differentiability with multi variable	**K2**
Unit II		
Objective 2	Aim to introduce Rank theorem	
Implicit function theorem - Rank theorem – Determinants – Jacobians – Derivatives of higher order – Differentiation of integrals.		
Outcome2	Understand the proof of Rank theorem	**K2**
Unit III		
Objective 3	Introducing different types of differential forms	
Primitive mappings – Partitions of unity – Change of variables – Differential forms – Elementaryproperties – Products of basic k-forms – Multiplication.		
Outcome3	Know the basic theory of different types of differential forms	**K2**
Unit IV		
Objective 4	To investigate the affine simplex and affine chain	
Differentiation – Change of variables– Affine simplex – Affine chain – Differentiable simplex andchains – Positively oriented boundaries.		
Outcome4	Consolidate earlier knowledge of affine simplex and affine chain relations throughapplications.	**K5**
Unit V		
Objective 5	To illustrate how general methods of Stokes formula can be used	
Stokes theorem – Closed forms and Exact forms – Vector fields – Volume elements – Green'stheorem – Arc elements – Stokes formula.		
Outcome5	Understand the applications of Stokes formula.	**K5**

Suggested Readings:

Rudin, W. (2016). *Principles of Mathematical Analysis* (3rd ed.). McGraw Hill.

Edwards, C.H. (1973). *Advanced Calculus of Several Variables*. New York: Academic Press Inc.

Francis Calrke, (2013). *Functional Analysis*. Calculus of Variations and Optimal Control. Springer.

Loomis, L. H., Sternberg, S. (1968). *Advanced Calculus*, Addison-Wesley Publishing Company, Inc.

Michael Spivak, (1995). *Calculus on Manifolds*. Addison-Wesley Publication Company.

Stewart, J. (2008). *Multivariable Calculus*. USA: Brooks/Cole.

Online Resources: http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics, http://www.opensource.org, www.mathpages.com

K1-Remember	*K2-Understand*	*K3- Apply*	*K4-Analyze*	*K5-Evaluate*	*K6-Create*

Course Designed by: Dr. B.Sundaravadivoo

Course Outcome VS Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	L(1)	M(2)	M(2)	M(2)	S(3)	M(2)	S(3)	M(2)	M(2)	L(1)
CO2	L(1)	M(2)	S(3)	M(2)	S(3)	S(3)	S(3)	M(2)	S(3)	L(1)
CO3	M(2)	L(1)	S(3)	M(2)	S(3)	S(3)	S(3)	M(2)	M(2)	S(3)
CO4	L(1)	M(2)	S(3)	S(3)	S(3)	M(2)	S(3)	M(2)	M(2)	L(1)
CO5	M(2)	L(1)	S(3)	S(3)	S(3)	M(2)	S(3)	M(2)	S(3)	M(2)
AVG	**1.4**	**1.6**	**2.8**	**2.4**	**3**	**2.4**	**3**	**2**	**2.4**	**1.6**

S –Strong (3), M-Medium (2), L- Low (1)

Course Outcome VS Programme Specific Outcomes

CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	L(1)	M(2)	M(2)	M(2)	S(3)
CO2	L(1)	M(2)	S(3)	M(2)	S(3)
CO3	L(1)	M(2)	M(2)	M(2)	S(3)
CO4	L(1)	M(2)	M(2)	S(3)	S(3)
CO5	M(2)	S(3)	S(3)	S(3)	S(3)
AVG	**1.2**	**2.2**	**2.4**	**2.4**	**3**

S –Strong (3), M-Medium (2), L- Low (1)

Elective course					
DSE	**Course code: 511509**	**Algorithmic Graph Theory**	**T**	**Credits:5**	**Hours:5**

Unit -I		
Objective 1	This is a standard course in graph theory, assuming little introductory knowledge of graphs.It aim is to present all usual basic concepts of graph theory, graph properties (with simplified proofs) and formulations of typical graph problems.	
Adjacency matrices and adjacency lists, Depth First Search, Spanning trees, branching and connectivity.		
Outcome1	Strong background of Depth First search, Branch, and Connectivity.	**K2**
Unit II		
Objective 2	Various graphs algorithms will also be taught along with its analysis.	
Planar graphs – Genus, Crossing Number and Thickness, Dual Graphs, Planarity Testing Algorithm.		
Outcome 2	Understand the concept of Planarity Testing Algorithms.	**K3**
Unit III		
Objective 3	Theorems will be stated and proved formally using various techniques.	
Matchings and Eulerian graph, The Chinese Postman problem for directed and undirected graphs.		
Outcome3	Understand the concept of Directed and undirected graphs, Eulerian graphs and apply it into real life situations.	**K4**
Unit IV		
Objective 4	This is also supplemented with some abstract-level coloring problems. Although the contentof this course is primarily targeted at students, it is accessible also to others.	
Graph Colourings – Vertex and Edge Colourings, Chromatic polynomials, Four colour and Five colour theorems, Dominating and Independent sets.		
Outcome4	Design efficient graph coloring problems and Chromatic polynomials.	**K5**
Unit V		
Objective 5	This is a 'reading course' that explores algorithmic graph theory by visiting some of the key problems and tools. The main goal is to systematically present essential tools in designing efficient algorithms. Most of the key techniques from these algorithms have already found applications in optimization, machine learning and statistics.	
Complexity of graph problems - P and NP classes, Cook's theorem, NP-complete problems.		
Outcome 5	Use effectively techniques from graph theory with complexity and NP - Completenessproblems.	**K6**

Suggested Readings:

Allan Gibbons, *Algorithmic graph theory*, Cambridge University Press, 1985.

Berge, C. (1991). *Graphs*. First Edition, North Holland.

Bollabas, B. (1979). *Graph Theory: An Introductory Course*. Springer Verlag.

Gary Chartrand, Ortrud R. (1992). *Applied and Algorithmic Graph Theory*. Mc Graw Gill.Golumbic, M.C. (1980). *Algorithmic Graph Theory and Perfect Graphs*. Academic Press.Rosan, K. H. (2005). *Graphs, Algorithms and Optimization*. CRC Press, Florida, USA.

Online resources

https://ocw.mit.edu/courses/6-006-introduction-to-algorithms-spring-2020/video_galleries/lecture-videos/

https://www.coursera.org/learn/algorithms-on-graphs

https://ocw.mit.edu/courses/6-006-introduction-to-algorithms-fall-2011/

K1-Remember	*K2-Understand*	*K3- Apply*	*K4-Analyze*	*K5-Evaluate*	*K6-Create*

Course Designed by: Dr. S. Amutha

Course Outcome VS Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S (3)	L (1)	S (3)	M (2)	S (3)	S (3)	S (3)	M (2)	S (3)	S (3)
CO2	L (1)	L (1)	S (3)	L (1)	S (3)	S (3)	S (3)	L (1)	S (3)	S (3)
CO3	S (3)	M (2)	M (2)	L (1)	S (3)	S (3)	M (2)	L (1)	M (2)	S (3)
CO4	L (1)	M (2)	S (3)	M (2)	S (3)	S (3)	S (3)	M (2)	S (3)	S (3)
CO5	S (3)	L (1)	M (2)	S (3)	S (3)	S (3)	M (2)	S (3)	S (3)	S (3)
AVG	**2.2**	**1.4**	**2.6**	**1.8**	**3**	**3**	**2.6**	**1.8**	**2.8**	**3**

S –Strong (3), M-Medium (2), L- Low (1)

Course Outcome VS Programme Specific Outcomes

CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S (3)	M (2)	M (2)	M (2)	L (1)
CO2	S (3)	M (2)	M (2)	M (2)	L (1)
CO3	S (3)	M (2)	M (2)	M (2)	L (1)
CO4	S (3)	M (2)	M (2)	M (2)	L (1)
CO5	S (3)	M (2)	M (2)	M (2)	L (1)
AVG	**3**	**2**	**2**	**2**	**1**

S – Strong (3), M - Medium (2), L - Low (1)

Elective course					
DSE	**Course code: 511510**	**Introduction to Python Programming**	**T**	**Credits:5**	**Hours:5**

Unit -I

Objective 1	To learn the basics of File management, Syntax, Basic Tools of Programming etc.,	
Review of Linux commands – File management and permissions – Using VI editor– Introducing a programming language, syntax, basic tools, simple programmes,etc.		
Outcome1	Comprehend Python Programming and basic commands.	**K-1**

Unit II

Objective 2	To inculcate professional training in program files, Conditionals, Python keywords and function names.	
Basic Tools – First Program file – Handling complex numbers – Functions and loops– Standard math functions; Conditionals; Python keywords and function names; Defining Names.		
Outcome2	Make them learn basic tools, functions and loops.	**K-2**

Unit III

Objective 3	Introduce the lists in Python, Loops, Range function, Queues etc.,	
Lists in Python – Defining and accessing lists – Loops with lists – Range function – for loop with lists for sorting – Built-in sort functions – else class in loops – slicing lists – lists as stacks – using lists as queues – new lists from old.		
Outcome3	Get expertise in Standard math functions.	**K-4**

Unit IV

Objective 4	To illustrate how to use data types, Format, Specifiers and Tuples.	
Data types – Numeric Types – Tuples – Accepting tuple inputs – sorting iterables –the lambda function – Sets – Dictionaries – Input and output – Output formatting– Format specifiers – align, sign, width, precision, type – File operations – Functions from Numpy and Scipy libraries.		
Outcome4	Understand basic various formats of listing and data types.	**K-6**

Unit V

Objective 5	Discuss the concept of Math problems like Plotting curves, Angle between vectors etc.,	
Math problems for practice which includes the following: (a) Finding GCD of two or more integers; (b) Primality checking; Finding primes up to a given integer; (c) Plotting curves; (d) Area of a triangle; (e) Angle between vectors; (f) Convert a number in decimal to a given base n. (g) Transpose of a matrix; Product of two matrices; (h)Finding the mean; median; mode; standard deviation etc., of a given data.		
Outcome5	Get expertise in various mathematical problems.	**K-5**

Suggested Readings:

David Amos, Dan Bader, Joanna Jablonski, Fletcher Heisler(2020), *Python Basics: A Practical Introduction to Python 3*,fourth edition,Real Python.

Qingkai kong, Timmy Siauw, Alexandere Bayen(2020), *Python Programming and numerical methods*, A Guide for engineers and Scientists.

Brian Heinold(2012), *A Practical Introduction to python programming*.

Online resources

https://static.realpython.com/python-basics-sample-chapters.pdf

https://pythonnumericalmethods.berkeley.edu/notebooks/Index.html

https://www.brianheinold.net/python/A_Practical_Introduction_to_Python_Programming_Heinold.pdf

K1-Remember	***K2-Understand***	***K3- Apply***	***K4-Analyze***	***K5-Evaluate***	***K6-Create***

Course Designed by: Dr. N. Anbazhagan

Course Outcome VS Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	L(1)	M(2)	M(2)	M(2)	S(3)	M(2)	M(2)	L(1)	L(1)	M(2)
CO2	M(2)	M(2)	M(2)	M(2)	S(3)	S(3)	M(2)	L(1)	L(1)	M(2)
CO3	S(3)	L(1)	M(2)	M(2)	L(1)	M(2)	M(2)	M(2)	M(2)	M(2)
CO4	M(2)	L(1)	L(1)	S(3)	M(2)	M(2)	L(1)	M(2)	M(2)	M(2)
CO5	L(1)	M(2)	S(3)	S(3)	M(2)	M(2)	M(2)	L(1)	L(1)	M(2)
AVG	**1.8**	**1.6**	**2**	**2.4**	**2.2**	**2.2**	**1.8**	**1.4**	**1.4**	**2**

S –Strong (3), M-Medium (2), L- Low (1)

Course Outcome VS Programme Specific Outcomes

CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M(2)	M(2)	S(3)	S(3)	L(1)
CO2	L(1)	M(2)	M(2)	M(2)	S(3)
CO3	S(3)	S(3)	M(2)	M(2)	L(1)
CO4	M(2)	M(2)	M(2)	M(2)	L(1)
CO5	M(2)	S(3)	S(3)	M(2)	M(2)
AVG	**2**	**2.4**	**2.4**	**2.2**	**1.6**

S –Strong (3), M-Medium (2), L- Low (1)

Elective Course					
DSE	**Course code: 511511**	**MATLAB**	**T**	**Credits: 5**	**Hours: 5**

Unit -I		
Objective 1	MATLAB was primarily designed to do numerical calculations and computer algebra systems were failed to do. By learning the software packages along with some exercises will be built up some knowledge in this course	
Introduction – Basics of MATLAB, Input-Output, File types – Platform dependence – General commands.		
Outcome 1	Build programs to solve Engineering problems, apply MATLAB conventions and good programming practices	**K3**
Unit II		
Objective 2	The basic building block of MATLAB is the matrix. Vectors, scalars, real matrices, and complex matrices are special cases of basic data types. The built-in functions used to optimize the vector operations. Consequently, it runs commands or codes much faster in MATLAB	
Interactive computation: Matrices and vectors – Matrix and array operations – Creating and using Inline functions – Using Built in functions and Online help – Saving and loading data – Plotting simple graphs.		
Outcome 2	Implement loops, branching, control instruction and functions in MATLAB programming environment and to program curve fitting, numerical differentiation and integration, solution of linear equations in MATLAB and solve electrical engineering problems.	**K6**
Unit III		
Objective 3	Most of the script and functions use state-of-the-art algorithms. Since they allow the learners to reuse sequences of commands by storing them in code files	
Programming in MATLAB: Scripts and functions – Script files – Function files – Language specific features – Advanced data objects.		
Outcome 3	Learners apply the graphic features in MATLAB effectively in various applications	**K3**
Unit IV		
Objective 4	To provide an overview to program curve fitting & solve Linear and Nonlinear Equations.	
Applications – Linear Algebra – Curve fitting and interpolation – Data analysis and statistics – Numerical integration – Ordinary differential equations – Nonlinear algebraic equations.		
Outcome 4	Analyze the program for correctness and determine/estimate/predict the output and verify it under simulation environment using MATLAB tools	**K6**
Unit V		
Objective 5	The 2D and 3D plot function enable us to create a graphical representation of the data for the considered problem	
Graphics: Basics 2D plots – Using subplot to layout multiple graphs – 3D plots – Handle graphics – Saving and printing graphics – Errors – Some applications functions – Data analysis & Fourier transforms – Polynomials and data interpretation - Nonlinear numerical methods.		
Outcome 5	Students be able to apply the graphics in the industry as a MATLAB Programmer and to work as a data analyst with the knowledge of data analysis.	**K6**

Suggested Readings:

Rudra Pratap. (2010). Getting Started with MATLAB – A Quick Introduction for Scientists and Engineers. Oxford University Press.

William John. P. (2005). *Introduction to Matlab 7 for Engineers*. Mc Graw-Hill Professional.

Dolores Etter, M., David C. Kuncicky, (2004). *Introduction to Matlab 7*. Prentice Hall.

Stephen J. Chapman, (1999). Matlab Programming for Engineers. (4th ed.). Cl Engineering.

Edward Magrab, B. Balakumar, B. Duncan, J. Walsh, G. Azarm, S., Keith E. Herold, (2000). *An Engineers Guide to Matlab*. (3rd ed.). Pearson.

Online resources					
https://in.mathworks.com/solutions/control-systems/resources.html https://itservices.usc.edu/matlab/resources/ https://matlabacademy.mathworks.com/					
K1-Remember	***K2-Understand***	***K3- Apply***	***K4-Analyze***	***K5-Evaluate***	***K6-Create***
Course Designed by: Dr.R.RAJA					

Course Outcome VS Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S (3)	M (2)	S (3)	S (3)	M (2)	M (2)	M (2)	L (1)	S (3)	S (3)
CO2	M (2)	L (1)	M (2)	S (3)	M (2)	L (1)	L (1)	L (1)	S (3)	S (3)
CO3	M (2)	L (1)	S (3)	S (3)	L (1)	L (1)	L (1)	L (1)	M (2)	S (3)
CO4	S (3)	L (1)	S (3)	S (3)	M (2)	M (2)	M (2)	L (1)	M (2)	S (3)
CO5	M (2)	L (1)	M (2)	S (3)	M (2)	M (2)	M (2)	L (1)	M (2)	S (3)
AVG	**2.4**	**1.2**	**2.6**	**3.0**	**1.8**	**1.6**	**1.6**	**1.0**	**2.4**	**3.0**

S –Strong (3), M-Medium (2), L- Low (1)

Course Outcome VS Programme Specific Outcomes

CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S (3)	S (3)	S (3)	S (3)	L (1)
CO2	S (3)	S (3)	S (3)	S (3)	L (1)
CO3	S (3)	S (3)	S (3)	S (3)	L (1)
CO4	S (3)	S (3)	S (3)	S (3)	L (1)
CO5	S (3)	S (3)	S (3)	S (3)	L (1)
AVG	**3.0**	**3.0**	**3.0**	**3.0**	**1.0**

S –Strong (3), M-Medium (2), L- Low (1)

Elective Course					
DSE	**Course code: 511512**	**Financial Mathematics**	**T**	**Credits:5**	**Hours:5**
Unit -I					
Objective 1	Introduce the financial securities, accumulating factors and study about interests and value ofmoney				
Basic Financial Calculations: Introduction: financial securities- zero coupon bond, fixed interest, index linked securities etc.; the time value of money; nominal Vs. real interest, deflationary conditions; accumulating factors, force of interest, compound interest functions.					
Outcome1	Handle the financial securities, accumulating factors, force of interest and compound interestfunctions in financial institutions				**K2**
Unit II					
Objective 2	Discuss about annuities and equation of values				
Annuities and Equation of Value: Discounting and Accumulation: discrete and continuous cash flows; level annuities, deferred and increasing/decreasing annuities, equation of value and yield on transaction, probability of cash flows, higher discount, loan schedules; consumer credit: flat rate and APRs.					
Outcome 2	Find annuities, equation of values and get the probability of cash flow, discount, flat rate and APRs.				**K3**
Unit III					
Objective 3	Introduce the financial statements and learn about equities, internal rate of return, payback period; valuing a loan with allowance for capital gains and indexation				
Capital Budgeting Techniques and Compound Interest Problems: Introduction to financial statement, assessing financial performance, net present value, internal rate of return, payback period; projects with different lives; money and time weighed rate of return; fixed interest securities, uncertain income securities, equities, valuing a loan with allowance for capital gains and indexation					
Outcome3	Use the financial statements, equities, internal rate of return, payback period, valuing a loan withallowance for capital gains and indexation in appropriate area of finance.				**K4**
Unit IV					
Objective 4	Apply the "efficient market hypothesis" and the Arbitrage Theorem and their implications invarious financial modeling situations				
Arbitrage, Forward Contracts, and Term Structure of Interest: Rationale for no arbitrage assumption; forward contracts, calculating the forward price for a security with known dividend yield; hedging, fixed cash income; Discrete time and continuous time rates; continuous time spot rates and forward rates; instantaneous forward rates; theories of time; term structure of interest rates; yield curve; yields to maturity; convexity and immunization; interest rate risk.					
Outcome4	Apply the "efficient market hypothesis" and the Arbitrage Theorem and their implications invarious financial modeling situations.				**K3**
Unit V					
Objective 5	Approximate discrete stochastic processes by continuous stochastic processes and vice versa				
Stochastic Interest Models and Investments: Simple stochastic interest rate models, fixed and varying interest model, log normal distribution; fixed interest government borrowings, government bonds, tax, security, marketability and return; government bills: corporate debt, debentures, unsecured loan stocks, eurobonds, certificates of deposit, convertibles, property, derivatives, future, range of futures, clearing house, margin, bond futures, short interest futures, stock index futures.					
Outcome5	Demonstrate the appropriateness of modeling or numerical solutions in analyzing common problems in banks and other financial institutions.				**K6**

Suggested Readings:

Baxter, M., Rennie, A. L. (1996). *Financial Calculus*. Cambridge University Press.

Karatzas, L., Shreve, S.E. (1998). *Methods of Mathematical Finance*. Springer. Martin, P.G.,

Michael, B. (1991). *Applied Financial Mathematics*. Prentice Hall.

Ross, S.M. (1999). *An Introduction to Mathematical Finance*. Cambridge University Press, Norton, London.

Watsham, T.J., Perramore, K. (1997). *Quantitative Methods in Finance*. International Thomson Business Press.

Online resources					
https://onlinecourses.nptel.ac.in/noc20_me36/preview https://ocw.mit.edu/courses/15-414-financial-management-summer-2003					
K1-Remember	***K2-Understand***	***K3- Apply***	***K4-Analyze***	***K5-Evaluate***	***K6-Create***
Course Designed by: Dr.M.Mullai					

Course Outcome VS Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S(3)	L(1)	L(1)	M(2)	S(3)	M(2)	L(1)	S(3)	M(2)	L(1)
CO2	S(3)	S(3)	S(3)	M(2)	L(1)	S(3)	S(3)	M(2)	L(1)	M(2)
CO3	L(1)	M(2)	S(3)	L(1)	S(3)	M(2)	M(2)	S(3)	S(3)	M(2)
CO4	M(2)	L(1)	M(2)	S(3)	M(2)	L(1)	M(2)	L(1)	M(2)	S(3)
CO5	M(2)	S(3)	L(1)	S(3)	S(3)	S(3)	L(1)	M(2)	S(3)	M(2)
AVG	**2.2**	**2**	**2.4**	**2.2**	**2.4**	**2.2**	**2**	**2.2**	**2.2**	**2**

S –Strong (3), M-Medium (2), L- Low (1)

Course Outcome VS Programme Specific Outcomes

CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S(3)	M(2)	L(1)	S(3)	M(2)
CO2	M(2)	L(1)	S(3)	M(2)	S(3)
CO3	L(1)	M(2)	S(3)	M(2)	S(3)
CO4	S(3)	M(2)	S(3)	S(3)	L(1)
CO5	L(1)	S(3)	M(2)	S(3)	M(2)
AVG	**2**	**2**	**2.4**	**2.6**	**2.2**

S –Strong (3), M-Medium (2), L- Low (1)

III - Semester					
Core	**Course code: 511301**	**Classical Dynamics**	**T**	**Credits:5**	**Hours:6**
Unit -I					
Objective 1	To introduce some basic concepts of nonrelativistic classical dynamics which deals with the vectorial part of dynamics				
Mechanical system – Generalized coordinates – Constraints – Virtual work – Energy and momentum.					
Outcome 1	Learners understand the basic concepts of mechanics related to discrete and continuous mechanical systems, Cyclic coordinates and conservation theories				**K2**
Unit II					
Objective 2	Students understand the classical mechanics in the sense of Lagrange and apply the same to Rayleigh dissipation function				
Derivation of Lagrange's equations – Examples – Integrals of motion – Special applications of Lagrange's equations: Rayleigh dissipation function.					
Outcome2	Learners apply the Newton's laws of motion and conservation law of energy, linear and angular momentum to solve advanced problems involving the dynamic motion of classical mechanical system				**K3**
Unit III					
Objective 3	To acquire knowledge of the principle of Hamilton and how a physical system is determined by a variational problem for a functional based on a single function				
Hamilton's principle – Hamilton's equation – Other variations principle-Liouville's theorem.					
Outcome3	Students solve the equations of motion for complicated mechanical systems using the Lagrangian and Hamiltonian formulations of classical mechanics				**K6**
Unit IV					
Objective 4	To educate the principle of Hamiltonian function and its generalizations and having a tendency of physical systems to undergo changes that result in either to minimize or maximize the abstract quantity				
Hamilton principle function – Hamilton-Jacobi equation – Separability.					
Outcome4	Learners explore the application of Hamilton's equations in solving the equation of motion of a particle in a central force field, projectile motion of a body				**K3**
Unit V					
Objective 5	To understand the differential forms and to generalize them for the three-dimensional vector calculus (divergence, curl and gradient), a notion of generating functions and different forms of transformations				
Differential forms and generating functions – Special transformations – Lagrange and Poisson brackets - More general transformations.					
Outcome5	Learning generating function will enable to solve the equations of motion and obtain the solution for the same				**K2**

Suggested Readings:

Greenwood, D. T. (1985). *Classical Dynamics*. New Delhi: Prentice Hall of India.

Chandra, S. (2009). *Classical Mechanics: A Textbook*. UK: Alpha Science International.

Goldstein, H. (2001). *Classical Mechanics*. New Delhi: Narosa Publishing House.

John Taylor, R. (2005). *Classical Mechanics* (2nd ed.). California: University Science Books, Sausalito.

Rane N.C., Joag, P.S.C. (1991). *Classical Mechanics*. New Delhi: Tata McGraw Hill.

Synge J.L., Griffth, B.A. (1970). *Principles of Mechanics*. New York: McGraw Hill Book Co.

Online resources

https://www.damtp.cam.ac.uk/user/tong/dynamics.html

https://digitalcommons.uri.edu/classical_dynamics/

https://www.tutorialsduniya.com/notes/classical-dynamics-notes/

K1-Remember	*K2-Understand*	*K3- Apply*	*K4-Analyze*	*K5-Evaluate*	*K6-Create*

Course Designed by: Dr.R.RAJA

Course Outcome VS Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S (3)	M (2)	S (3)	S (3)	L (1)	M (2)	L (1)	L (1)	S (3)	S (3)
CO2	S (3)	L (1)	S (3)	S (3)	M (2)	M (2)	L (1)	M (2)	S (3)	S (3)
CO3	M (2)	L (1)	S (3)	S (3)	M (2)	L (1)	M (2)	L (1)	M (2)	S (3)
CO4	M (2)	L (1)	M (2)	S (3)	M (2)	M (2)	L (1)	L (1)	M (2)	S (3)
CO5	S (3)	M (2)	L (1)	S (3)	L (1)	L (1)	M (2)	L (1)	M (2)	S (3)
AVG	**2.6**	**1.4**	**2.4**	**3.0**	**1.6**	**1.6**	**1.4**	**1.2**	**2.4**	**3.0**

S –Strong (3), M-Medium (2), L- Low (1)

Course Outcome VS Programme Specific Outcomes

CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M (2)	S (3)	S (3)	M (2)	M (2)
CO2	M (2)	M (2)	S (3)	M (2)	L (1)
CO3	S (3)	S (3)	S (3)	M (2)	S (3)
CO4	S (3)	M (2)	S (3)	S (3)	S (3)
CO5	M (2)	M (2)	S (3)	M (2)	S (3)
AVG	**2.4**	**2.4**	**3.0**	**2.2**	**2.4**

S –Strong (3), M-Medium (2), L- Low (1)

III - Semester					
Core	**Course Code: 511302**	**Topology**	**T**	**Credits:5**	**Hours:6**
Unit -I					
Objective 1	Explain how to distinguish spaces by means of simple topological invariants (compactness, connectedness and the fundamental group).				
Topological spaces and continuous functions - Basis for a topology - The order topology - The product topology on X x Y - The subspace topology - Closed sets and limit points - Continuous functions.					
Outcome1	Define and illustrate the concept of topological spaces and continuous functions.				**K1**
Unit II					
Objective 2	Explain how to construct spaces by gluing and to prove that in certain cases that the result is homeomorphic to a standard space**.**				
The product topology - The Metric Topology - The Metric Topology (continued) - Connected spaces – Connected subspaces of the Real line.					
Outcome2	Define and illustrate the concept of product topology, quotient topology and connected spaces of the real line				**K2**
Unit III					
Objective 3	Construct simple examples of spaces with given properties and prove that related theorem.				
Compact Spaces - Compact subspaces of the Real line -Limit point compactness - Localcompactness.					
Outcome3	Derive a selection of theorems concerning topological spaces, continuous functions, compact spaces, and local compact spaces.				**K3**
Unit IV					
Objective 4	To introduce the student to elementary properties of topological spaces and structures introduce the student to elementary properties of topological spaces and structures definedon them.				
The countability axioms - The separation axioms Normal Spaces - The Urysohn Lemma - TheUrysohn Metrization theorem.					
Outcome4	Define and illustrate the concepts of the separation axioms and their properties.				**K5**
Unit V					
Objective 5	To introduce the student to maps between topological spaces and to develop the student's ability to handle abstract ideas of Mathematics and Mathematical proofs.				
The Tietze extension theorem - Imbedding of manifolds - The Tychonoff theorem - The Stone-Cech compactification.					
Outcome5	Prove a selection of related theorems, and describe different examples distinguishing general, geometric, and algebraic topology				**K6**

Suggested Readings:

James Munkres, R. (2016). *Topology* (2nd ed.). New Delhi: Pearson India.
Dugundji, J. (1975) *Topology*. New Delhi: Prentice Hall of India.
Simmons, G.F. (1963). *Introduction to Topology and Modern Analysis*. New York: McGraw Hill Co.
Stephen Willard. (1970). *General Topology*. Addition Wesley, Publishing Company.

Online resources:

https://nptel.ac.in/courses/111106054
https://ocw.mit.edu/courses/18-901-introduction-to-topology-fall-2004/

K1-Remember	*K2-Understand*	*K3- Apply*	*K4-Analyze*	*K5-Evaluate*	*K6-Create*

Course Designed by: Dr. S.Amutha

Course Outcome VS Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S(3)	M(2)	S(3)	M(2)	S(3)	S(3)	S(3)	M(2)	S(3)	S(3)
CO2	M(2)	L(1)	S(3)	L(1)	S(3)	S(3)	S(3)	M(2)	S(3)	S(3)
CO3	S(3)	M(2)	S(3)	M(2)	S(3)	S(3)	S(3)	L(1)	S(3)	S(3)
CO4	L(1)	M(2)	S(3)	M(2)	S(3)	S(3)	S(3)	M(2)	S(3)	S(3)
CO5	S(3)	M(2)	M(2)	S(3)	S(3)	S(3)	M(2)	S(3)	S(3)	S(3)
AVG	**2.4**	**1.8**	**2.8**	**2**	**3**	**3**	**2.8**	**2**	**3**	**3**

S –Strong (3), M-Medium (2), L- Low (1)

Course Outcome VS Programme Specific Outcomes

CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S(3)	S(3)	L(1)	M(2)	L(1)
CO2	S(3)	S(3)	L(1)	M(2)	L(1)
CO3	S(3)	S(3)	L(1)	M(2)	L(1)
CO4	S(3)	S(3)	L(1)	M(2)	L(1)
CO5	S(3)	S(3)	L(1)	M(2)	L(1)
AVG	**3**	**3**	**1**	**2**	**1**

S –Strong (3), M-Medium (2), L- Low (1)

III - Semester					
Core	**Course code: 511303**	**Calculus of Variations & Integral Equations**	**T**	**Credits:5**	**Hours:6**

Unit –I		
Objective 1	Discuss the concepts of variation and its properties, solving problems in Euler's equation and understanding the functional dependent on higher order derivatives and functions of several independent variables.	
Calculus of variations-Maxima and Minima-The simplest case-Natural bountry and transition conditions-Variational notation-More general case-Constraints and Lagrange's multipliers-Variable end points-Sturm-Liouville problems.		
Outcome1	Analyze the concepts of problems in Euler's equation, the functional dependent on higher order derivatives and the applications of functions of several independent variables.	**K2**

Unit-II		
Objective 2	Study about the movable boundary for a functional dependent on two functions, one side variations, reflection and refraction of externals and diffraction of light rays.	
Introduction-Problems of brachistochrone-problem of geodesics-Isoperimetric problem-Variation and its properties-Functions and functional- Comparison between the notion of extrema of a function and a functional.		
Outcome2	Solve the movable boundary for a functional dependent on two functions, reflection andrefraction of externals.	**K2**

Unit III		
Objective 3	Discuss the concept of Inverse formula, Bessel function, Linearity property and how to use Hankel Transform of the derivatives of the function, differential operators and Parsaval's Theorem.	
Hankel Transform : Definition – Inverse formula – Some important results for Bessel function – Linearity property – Hankel Transform of the derivatives of the function – Hankel Transform of differential operators – Parsaval's Theorem.		
Outcome3	Know about the Inverse formula, Bessel function and Linearity property, Hankel Transformof the derivatives of the function and Parsaval's Theorem.	**K4**

Unit IV		
Objective 4	Explore the regularity conditions and special kind of kernels, solving problems in Eigen values and eigen functions and study about convolution Integral, Fredholm alternative and approximate method.	
Linear Integral Equations - Definition, Regularity conditions – Special kind of kernels – Eigen values and eigen functions – Convolution Integral – the inner and scalar product of two functions – Notation – Reduction to a system of Algebraic equations – Examples –Fredholm alternative - Examples – An approximate method.		
Outcome 4	Solve problems in Eigen values, eigen functions, Fredholm alternative and approximatemethod.	**K4**

Unit V		
Objective 5	Learn to use the Volterra Integral equation, the resolvent kernel and method of solution of Fredholm.	
Method of successive approximations: Iterative scheme – Examples – Volterra Integral equation – Examples – Some results about the resolvent kernel. Classical Fredholm Theory: the method of solution of Fredholm – Fredholm's first theorem – Second theorem – Third theorem.		
Outcome 5	Apply Volterra Integral equation, resolvent kernel, Fredholm solution and understand about Fredholm's first, second theorem and third theorem.	**K5**

Suggested Readings:

Hildebrand, F.B. (1972). *Methods of Applied Mathematics* (2nd ed.). PHI, ND.
Ram Kanwal, P. (1971). *Linear Integral Equations Theory and Practice*. Academic Press.
Vasishtha, A.R. and Gupta, R.K. (2002). *Integral Transforms*. Krishna Prakashan Media Pvt Ltd, India.
Mikhlin, S.J.,1960: *Linear Integral Equations*(translated from Russian).Hindustan Book Agency
Snedden,I.N.,1966: *Mixed Boundary Values Problems in Potential Theory*.North Holland.

Online resources:

http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics,
http://www.opensource.org, www.mathpages.com

K1-Remember	*K2-Understand*	*K3- Apply*	*K4-Analyze*	*K5-Evaluate*	*K6-Create*

Course Designed by: Dr. B. Sundaravadivoo

Course Outcome VS Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	L(1)	M(2)	M(2)	M(2)	S(3)	M(2)	S(3)	M(2)	S(3)	L(1)
CO2	L(1)	M(2)	M(2)	M(2)	S(3)	S(3)	S(3)	M(2)	M(2)	L(1)
CO3	L(1)	M(2)	S(3)	M(2)	S(3)	S(3)	S(3)	M(2)	M(2)	L(1)
CO4	L(1)	M(2)	S(3)	S(3)	S(3)	M(2)	S(3)	M(2)	S(3)	L(1)
CO5	M(2)	L(1)	S(3)	S(3)	S(3)	M(2)	S(3)	M(2)	M(2)	M(2)
AVG	**1.2**	**1.8**	**2**	**2.4**	**3**	**2.4**	**3**	**2**	**2.4**	**1.2**

S –Strong (3), M-Medium (2), L- Low (1)

Course Outcome VS Programme Specific Outcomes

CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	L(1)	S(3)	M(2)	M(2)	S(3)
CO2	L(1)	M(2)	S(3)	M(2)	S(3)
CO3	L(1)	M(2)	M(2)	M(2)	S(3)
CO4	L(1)	M(2)	M(2)	S(3)	S(3)
CO5	M(2)	S(3)	S(3)	S(3)	S(3)
AVG	**1.2**	**2.4**	**2.4**	**2.4**	**3**

S –Strong (3), M-Medium (2), L- Low (1)

Elective Course					
DSE	**Course code: 511513**	**Stochastic Processes**	**T**	**Credits:5**	**Hours:5**

Unit –I

Objective 1	Study the definition of Markov chain and Classification of states and chains.

Definition of stochastic processes – Markov chains: definition, order of a Markov chain – Higher transition probabilities – Classification of states and chains –Stability of a Markov System- denumerable number of states and reducible chains.

Outcome1	Understand the basics in Markov chain, concepts and more about the transition probabilitymatrices.	**K2**

Unit II

Objective 2	Study about Markov process with discrete state space by knowing Poisson process and birth-and-death process.

Markov process with discrete state space: Poisson process and related distributions – Properties of Poisson process, Generalizations of Poisson processes – Birth and death processes – Markov Processes with Discrete State Space.

Outcome 2	Demonstrate the examples of Poisson process and Markov process.	**K1**

Unit III

Objective 3	Introduce and study Brownian motion, Weiner process and Uhlenbech process.

Markov processes with continuous state space: Introduction - Brownian motion **-** Weiner process and differential equations for Weiner process- Kolmogrov equations – first passage time distribution for Weiner process – Ornstein – Uhlenbech process.

Outcome3	Discuss and acquire knowledge about Brownian motion, Weiner process in differential equations.	**K4**

Unit IV

Objective 4	Study Branching process and its properties, Bellman Harris process.

Branching processes: Introduction – properties of generating functions of Branching process – Probability of extinction – Distribution of the total number of progeny conditional limit laws – Generalization of the classical Galton and Watson process – Bellman Harris process.

Outcome 4	Explain the concepts of branching process and Bellman-Harris Process.	**K3**

Unit V

Objective 5	Discuss the applications of Stochastic process in Markovian and Non-Markovian queues.

Stochastic processes in Queueing Systems: Concepts – Queueing model M/M/1 – transient behaviour of M/M/1 model – Birth and death process in Queueing theory: M/M/1 model and related distributions – M/M/ □/M/M/S– Non Markovian queues – P-K formula.

Outcome 5	Analyze various queueing models.	**K2**

Suggested Readings:

Medhi, J. (2017). *Stochastic Processes* (4th ed.). New Age International Private Limited.

Cinlar, E. (1975). *Introduction to Stochastic Processes*. New Jersey: Prentice Hall, Inc.

James Melsa, L., Andrew Sage, P. (1973). *An Introduction to Probability and Stochastic Processes.* New Jersey:Prentice Hall, Inc.

Robert Gallager, G., (2013). *Stochastic Processes: Theory for Applications*. Cambridge University Press.

Online resources

https://ocw.mit.edu/courses/18-445-introduction-to-stochastic-processes-spring-2015/

https://onlinecourses.nptel.ac.in/noc19_ma30/preview

K1-Remember	***K2-Understand***	***K3- Apply***	***K4-Analyze***	***K5-Evaluate***	***K6-Create***

Course Designed by: Dr. N. Anbazhagan

Course Outcome VS Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M(2)	M(2)	M(2)	S(3)	M(2)	M(2)	M(2)	M(2)	M(2)	S(3)
CO2	M(2)	L(1)	M(2)	S(3)	M(2)	M(2)	S(3)	M(2)	M(2)	S(3)
CO3	M(2)	L(1)	M(2)	S(3)	L(1)	M(2)	S(3)	L(1)	M(2)	S(3)
CO4	L(1)	M(2)	S(3)	S(3)	M(2)	L(1)	M(2)	L(1)	S(3)	S(3)
CO5	M(2)	M(2)	S(3)	S(3)	M(2)	M(2)	M(2)	M(2)	S(3)	S(3)
AVG	**1.8**	**1.6**	**2.4**	**3.0**	**1.8**	**1.8**	**2.4**	**1.6**	**2.4**	**3.0**

S –Strong (3), M-Medium (2), L- Low (1)

Course Outcome VS Programme Specific Outcomes

CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S(3)	M(2)	S(3)	S(3)	S(3)
CO2	S(3)	M(2)	S(3)	S(3)	S(3)
CO3	S(3)	S(3)	S(3)	S(3)	S(3)
CO4	M(2)	S(3)	S(3)	M(2)	M(2)
CO5	L(1)	S(3)	S(3)	M(2)	L(1)
AVG	**2.4**	**2.6**	**3.0**	**2.6**	**2.4**

S –Strong (3), M-Medium (2), L- Low (1)

Elective Course					
DSE	**CourseCode: 511514**	**Algebraic Number Theory**	**T**	**Credits:5**	**Hours:5**

Unit -I

Objective 1	Gain an understanding and appreciation of algebraic number theory and familiarity with the basic objects of study, namely number fields and their rings of integers.	
Algebraic numbers – Conjugates and discriminants – Algebraic integers – Integral bases – Normsand traces – Quadratic fields – Cyclotomic fields.		
Outcome1	Understand the concept of algebraic numbers and algebraic integers.	**K2**

Unit II

Objective 2	Enable them to become comfortable working with the basic algebraic concepts involved, to appreciate the failure of unique factorization in general, and to see applications of the theory to Diophantine equations.	
Factorization into irreducibles – Example of non-unique factorization into irreducibles – Prime factorization – Euclidean domains – Euclidean quadratic fields – Consequences of unique factorization – Ramanujan-Nagell theorem.		
Outcome2	Know to factorize an algebraic integer into irreducible.	**K3**

Unit III

Objective 3	Study the concept of ideals and prime factorization of fields.	
Ideals – Prime factorization of fields – Norm of an ideal.		
Outcome3	Understand the concept of the ideals of a ring of integers in an algebraic number field.	**K4**

Unit IV

Objective 4	Introduce the concept of Lattices, Quotient torus and various theorems.	
Lattices – Quotient torus – Minkowski's theorem – the two-square theorem – the four-squaretheorem – The space L.		
Outcome4	Classify the class group, and find the class order in some cases.	**K4**

Unit V

Objective 5	Learn the definition of Fermat's Last theorem and historical background.	
Fermat's last theorem– Historical background –Elementary considerations– Kummer's lemma – Kummer's theorem.		
Outcome5	Understand the concept of finding the greatest common divisor.	**K5**

Suggested Readings:

Stewart, I., Tall, D. (2002). *Algebraic Number Theory and Fermat's Last Theorem* (3rd ed.). Chapman and HallMathematics Series.

Robert Ash, B. (2003). *A Course in Algebraic Number Theory*. USA: Dover Publications. Samuel, P. (1970). *Algebraic Theory of Numbers*. New York: Dover Publications, Mineola. Weiss, E. (1963). *Algebraic Number theory*. New York: Mc Graw Hill.

Online resources

https://ocw.mit.edu/courses/18-786-topics-in-algebraic-number-theory-spring-2006/

https://onlinecourses.swayam2.ac.in/cec20_ma15/preview

K1-Remember	*K2-Understand*	*K3- Apply*	*K4-Analyze*	*K5-Evaluate*	*K6-Create*

Course Designed by: Dr. R. Jeyabalan

Course Outcome VS Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S(3)	M(2)	S(3)	S(3)	M(2)	M(2)	M(2)	S(3)	S(3)	S(3)
CO2	S(3)	S(3)	M(2)	M(2)	S(3)	M(2)	S(3)	M(2)	L(1)	S(3)
CO3	M(2)	M(2)	L(1)	S(3)	M(2)	M(2)	M(2)	S(3)	S(3)	M(2)
CO4	S(3)	S(3)	S(3)	M(2)	M(2)	S(3)	M(2)	S(3)	S(3)	S(3)
CO5	M(2)	M(2)	S(3)	S(3)	S(3)	S(3)	S(3)	S(3)	M(2)	M(2)
AVG	**2.6**	**2.4**	**2.4**	**2.6**	**2.4**	**2.4**	**2.4**	**2.8**	**2.4**	**2.6**

S –Strong (3), M-Medium (2), L- Low (1)

Course Outcome VS Programme Specific Outcomes

CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S(3)	S(3)	M(2)	S(3)	S(3)
CO2	S(3)	M(2)	S(3)	L(1)	M(2)
CO3	L(1)	M(2)	M(2)	S(3)	S(3)
CO4	M(2)	S(3)	S(3)	M(2)	S(3)
CO5	S(3)	M(2)	S(3)	S(3)	S(3)
AVG	**2.4**	**2.4**	**2.4**	**2.4**	**2.8**

S –Strong (3), M-Medium (2), L- Low (1)

Elective Course					
DSE	**Course Code: 511515**	**Theory of Operators**	**T**	**Credits:5**	**Hours:5**

Unit -I

Objective 1	Examine the basic techniques for the spectral analysis of linear operators

Spectral theory of linear operators in normed spaces – Spectral theory on finite dimensional normed spaces – Basic concepts – Spectral properties of bounded linear operators – Properties of resolvent and spectrum – Banach algebra

Outcome 1	Understand the basic techniques for the spectral analysis of linear operators.	**K2**

Unit II

Objective 2	Discuss the spectral properties of compact linear operators on normed spaces

Compact linear operators on normed spaces – Properties – Spectral properties of compact linearoperators on normed spaces

Outcome 2	Apply the spectral properties of compact linear operators on normed spaces.	**K3**

Unit III

Objective 3	Demonstrate the behaviors of compact linear operators with respect to solvability of operator equations and Fredholm theorems

Behaviors of compact linear operators with respect to solvability of operator equations- Fredholm type theorems- Fredholm alternative theorm- Fredholm alternative for integral equations.

Outcome3	Understand and analyze the behaviors of compact linear operators with respect to solvability of operator equations and Fredholm theorems.	**K4**

Unit IV

Objective 4	Learn the concept of complex Hilbert space, positive operators and monotone sequencestheorem

Spectral properties of bounded self adjoint linear operator – on a complex Hibert space - Positive operators - Monotone Sequences theorem for bounded self-adjoint operators on a complex Hilbertspace – Square roots of a positive operator.

Outcome 4	Interpret the concept of complex Hilbert space, positive operators and monotone sequences theorem.	**K5**

Unit V

Objective 5	Discuss the properties of projection operator and discuss about spectral family of bounded self adjoint linear operators

Projection operators and their properties – Spectral family – Spectral family of bounded selfadjoint linear operators

Outcome5	Understand the properties of projection operator and discuss about spectral family of boundedself adjoint linear operators.	**K6**

Suggested Readings:

Akniezer, N.I., Glazman, I.M. (1961). *Theory of Linear Operators in Hilbert Spaces*. New York: Ungar.

Conway, J. B. (1985). *Course in Functional Analysis*. New York: Springer-Verlag

Kreyszig, E. (2019). *Introductory Functional Analysis with its Applications*. John Wiley

Peter Lax, D. (2002). *Functional Analysis*. Warszawa, Wiley- Inder Science.

P.R. Halmos(1957). *Introduction to Hilbert space and the theory of spectral multiplicity*, 2nd Edn. Chelsea Pub., Co.,N.Y.

Online resources

https://onlinecourses.nptel.ac.in/noc22_ma63/preview

K1-Remember	***K2-Understand***	***K3- Apply***	***K4-Analyze***	***K5-Evaluate***	***K6-Create***

Course Designed by: Dr. M. Mullai

Course Outcome VS Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M(2)	S(3)	L(1)	M(2)	S(3)	M(2)	M(2)	S(3)	S(3)	L(1)
CO2	L(1)	M(2)	M(2)	L(1)	M(2)	S(3)	L(1)	M(2)	M(2)	M(2)
CO3	S(3)	S(3)	S(3)	S(3)	L(1)	M(2)	S(3)	L(1)	S(3)	S(3)
CO4	M(2)	S(3)	M(2)	L(1)	M(2)	L(1)	M(2)	S(3)	S(3)	L(1)
CO5	S(3)	L(1)	L(1)	M(2)	S(3)	M(2)	S(3)	M(2)	M(2)	S(3)
AVG	**2.2**	**2.4**	**1.8**	**1.8**	**2.2**	**2**	**2.2**	**2.2**	**2.6**	**2**

S –Strong (3), M-Medium (2), L- Low (1)

Course Outcome VS Programme Specific Outcomes

CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M(2)	L(1)	L(1)	S(3)	M(2)
CO2	L(1)	S(3)	S(3)	L(1)	S(3)
CO3	S(3)	L(1)	L(1)	M(2)	M(2)
CO4	S(3)	S(3)	M(2)	M(2)	L(1)
CO5	L(2)	M(2)	L(1)	S(3)	L(1)
AVG	**2.2**	**2**	**1.6**	**2.2**	**1.8**

S –Strong (3), M-Medium (2), L- Low (1)

Elective Course					
DSE	**CourseCode: 511516**	**Coding Theory**	**T**	**Credits:5**	**Hours:5**

Unit -I		
Objective 1	Explain the basic concepts of coding for reliable digital transmission and storage	
Coding for Reliable Digital Transmission and storage: Mathematical model of Information, ALogarithmic Measure of Information, Average and Mutual Information and Entropy, Types of Errors, Error Control Strategies. Linear Block Codes: Introduction to Linear Block Codes, Syndrome and ErrorDetection, Minimum Distance of a Block code, Error-Detecting and Error-correcting Capabilities of a Block code, Standard array and Syndrome Decoding, Probability of an undetected error for Linear Codes over a BSC, Hamming Codes. Applications of Block codes for Error control in data storage system		
Outcome1	Handle the information model, linear block codes, error deduction and syndrome decoding inapplications.	**K2**
Unit II		
Objective 2	Identify and solve various types of cyclic codes	
Cyclic Codes : Description, Generator and Parity-check Matrices, Encoding, Syndrome Computation and Error Detection, Decoding ,Cyclic Hamming Codes, Shortened cyclic codes, Error-trapping decoding for cyclic codes, Majority logic decoding for cyclic codes		
Outcome 2	Apply the cyclic hamming codes, error deduction and majority logic decoding for cyclic codes in various fields.	**K3**
Unit III		
Objective 3	Explain and evaluate encoding and decoding of convolutional codes	
Convolutional Codes: Encoding of Convolutional Codes, Structural and Distance Properties, maximum likelihood decoding, Sequential decoding, Majority- logic decoding of Convolution codes. Application of Viterbi Decoding and Sequential Decoding, Applications of Convolutional codes in ARQ system		
Outcome 3	Understand the use of the convolutional codes and their applications in various systems.	**K5**
Unit IV		
Objective 4	Examine the LDPC codes, UMTS Turbo codes and concatenated convolutional codes	
Turbo Codes: LDPC Codes- Codes based on sparse graphs, Decoding for binary erasure channel, Log-likelihood algebra, Brief propagation, Product codes, Iterative decoding of product codes, Concatenated convolutional codes- Parallel concatenation, The UMTS Turbo code, Serial concatenation, Parallel concatenation, Turbo decoding		
Outcome4	Analyze the applications of decoding for binary erasure channel, Log-likelihood algebra, Product codes, concatenated convolutional codes, The UMTS Turbo code, Serial concatenation, Parallel concatenation, and Turbo decoding.	**K4**
Unit V		
Objective 5	Introduce digital modulation schemes, diversity, space time codes and spatial multiplexing	
Space-Time Codes: Introduction, Digital modulation schemes, Diversity, Orthogonal space- Time Block codes, Alamouti's schemes, Extension to more than Two Transmit Antennas, Simulation Results, Spatial Multiplexing : General Concept, Iterative APP Preprocessing and Per-layer Decoding, Linear Multilayer Detection, Original BLAST Detection, QL Decomposition and Interface Cancellation, Performance of Multi – Layer Detection Schemes, Unified Description by Linear Dispersion Codes		
Outcome 5	Understand Digital modulation schemes, Diversity, Time Block codes, Alamouti's schemes, spatial multiplexing, and performance of multi – Layer Detection Schemes and unifiedDescription by Linear Dispersion Codes.	**K6**

Suggested Readings:

Van Lint, J.H,(1998) "*Introduction to Coding Theory",* (3rd Edition) , Springer, New Delhi.

Shu Lin, Daniel J.Costello,Jr, "*Error Control Coding- Fundamentals and Applications*", Prentice Hall, Inc.Man Young Rhee, "*Error Correcting Coding Theory*", 1989, McGraw-Hill

Bernard Sklar, "*Digital Communications-Fundamental and application*",

PE.John G. Proakis, "*Digital Communications*", 5th Edition, 2008,

MH.Salvatore Gravano, "*Introduction to Error Control Codes*", Oxford University Press.

Todd K.Moon, *"Error Correction Coding – Mathematical Methods and Algorithms*", 2006, Wiley India.

Ranjan Bose, "*Information Theory, Coding and Cryptography"*, 2nd Edition, 2009, TMH.

Online resources

https://ocw.mit.edu/courses/6-895-essential-coding-theory-fall-2004/

https://onlinecourses.nptel.ac.in/noc20_ee94/preview

K1-Remember	*K2-Understand*	*K3- Apply*	*K4-Analyze*	*K5-Evaluate*	*K6-Create*

Course Designed by: Dr. M. Mullai

Course Outcome VS Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M(2)	S(3)	L(1)	L(1)	S(3)	M(2)	S(3)	S(3)	M(2)	S(3)
CO2	L(1)	M(2)	M(2)	S(3)	M(2)	S(3)	S(3)	M(2)	S(3)	M(2)
CO3	S(3)	S(3)	M(2)	M(2)	L(1)	M(2)	L(1)	L(1)	S(3)	L(1)
CO4	M(2)	L(1)	M(2)	S(3)	M(2)	L(1)	M(2)	S(3)	L(1)	M(2)
CO5	M(2)	M(2)	L(1)	M(2)	L(1)	M(2)	S(3)	M(2)	M(2)	L(1)
AVG	**2**	**2.2**	**1.6**	**2.2**	**1.8**	**2**	**2.4**	**2.2**	**2.2**	**2**

S –Strong (3), M-Medium (2), L- Low (1)

Outcome VS Programme Specific Outcomes

CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M(2)	M(2)	S(3)	M(2)	S(3)
CO2	M(2)	M(2)	M(2)	M(2)	L(1)
CO3	S(3)	L(1)	S(3)	L(1)	S(3)
CO4	S(3)	M(2)	L(1)	M(2)	L(1)
CO5	M(2)	L(1)	S(3)	M(2)	S(3)
AVG	**2.4**	**1.6**	**2.4**	**1.8**	**2.2**

S –Strong (3), M-Medium (2), L- Low (1)

Elective Course					
DSE	**Course Code: 511517**	**Data Analytics**	**T**	**Credits:5**	**Hours:5**

Unit -I		
Objective 1	Explain the challenges of conventional systems, the concept of web data, analytic scalability, analytic process and tool and apply the concept of statistical tools	
Introduction to Big Data Platform – Challenges of conventional systems - Web data – Evolution of Analytic scalability, analytic processes and tools, Analysis vs reporting - Modern data analytic tools, Stastical concepts: Sampling distributions, resampling, statistical inference, prediction error.		
Outcome1	Understand the concept of web data, analytic scalability, analytic process and tools and apply the concept of statistical tools.	**K2**
Unit II		
Objective 2	Identify the concept of regression and Bayesian models, network models and the use of fuzzylogic	
Data Analysis-Regression modeling, Multivariate analysis, Bayesian modeling, inference and Bayesian networks, Support vector and kernel methods, Analysis of time series: linear systems analysis, nonlinear dynamics - Rule induction - Neural networks: learning and generalization, competitive learning, principal component analysis and neural networks; Fuzzy logic: extracting fuzzy models from data, fuzzy decision trees, Stochastic search methods		
Outcome2	Understand the regression and bayesian models and use of network models and fuzzy logicin real life applications	**K3**
Unit III		
Objective 3	Classify and analyze various streams concepts and understand Real time Analytics Platform(RTAP)Applications	
Mining data streams : Introduction To Streams Concepts – Stream Data Model and Architecture - Stream Computing - Sampling Data in a Stream – Filtering Streams – Counting Distinct Elements in a Stream – Estimating Moments – Counting Oneness in a Window – Decaying Window - Real time Analytics Platform(RTAP) Applications - Case Studies - Real Time Sentiment Analysis- Stock Market Predictions.		
Outcome3	Analyze the Real time Analytics Platform(RTAP) Applications and how to predict the Stock Market problems.	**K4**
Unit IV		
Objective 4	Explain the applications on Big Data Using Pig and Hive, and study about IBM Info Sphere Big Insights and streams	
Frameworks: Applications on Big Data Using Pig and Hive – Data processing operators in Pig – Hive services – HiveQL – Querying Data in Hive - fundamentals of HBase and ZooKeeper - IBM InfoSphere BigInsights and Streams		
Outcome 4	Evaluate the use of applications on Big Data Using Pig and Hive and the programmingtools PIG & HIVE in Hadoop echo system.	**K5**
Unit V		
Objective 5	Discuss about types of linear regressions, search methods and visualization method	
Predictive Analytics - Simple linear regression- Multiple linear regression - Interpretation 5 of regression coefficients. Visualizations - Visual data analysis techniques- interaction techniques - Systems and applications		
Outcome5	Understand the various search methods, visualization techniques and Interaction techniques.	**K6**

Suggested Readings:

Berthold, M., David J. Hand. (2007). *Intelligent Data Analysis*. Springer.

Eaton, C. DeRoos, D. Deutsch, T. Lapis,G. Zikopoulos, P. (2012). *Understanding Big Data: Analytics for EnterpriseClass Hadoop and Streaming Data*. McGrawHill Publishing.

Han,J., Kamber,M. (2008). *Data Mining Concepts and Techniques*. Second Edition, Elsevier.

Franks,B. (2012). *Taming the Big Data Tidal Wave*: Finding Opportunities in Huge Data Streams with AdvancedAnalytics. John Wiley& sons.

Glenn J. Myatt(2011). Making Sense of Data, John Wiley & Sons, 2007 Pete Warden, Big Data Glossary, O" Reilly,2011.

Anand Rajaraman and Jeffrey David Ullman(2012). *Mining of Massive Datasets*,Cambridge University Press.

Online resources					
https://onlinecourses.nptel.ac.in/noc21_mg02/preview https://ocw.mit.edu/courses/18-s096-topics-in-mathematics-of-data-science-fall-2015/					
K1-Remember	***K2-Understand***	***K3- Apply***	***K4-Analyze***	***K5-Evaluate***	***K6-Create***
Course Designed by: Dr. M. Mullai					

Course Outcome VS Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M(2)	L(1)	L(1)	M(2)	S(3)	M(2)	S(3)	S(3)	M(2)	S(3)
CO2	L(1)	S(3)	M(2)	L(1)	M(2)	S(3)	S(3)	M(2)	S(3)	M(2)
CO3	S(3)	S(3)	M(2)	S(3)	L(1)	M(2)	M(2)	S(3)	M(2)	L(1)
CO4	M(2)	M(2)	L(1)	L(1)	M(2)	S(3)	M(2)	L(1)	M(2)	S(3)
CO5	M(2)	M(2)	S(3)	S(3)	S(3)	M(2)	L(1)	M(2)	L(1)	S(3)
AVG	**2**	**2.2**	**1.8**	**2**	**2.2**	**2.4**	**2.2**	**2.2**	**2**	**2.4**

S –Strong (3), M-Medium (2), L- Low (1)

Course Outcome VS Programme Specific Outcomes

CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S(3)	S(3)	M(2)	M(2)	L(1)
CO2	M(2)	S(3)	S(3)	M(2)	L(1)
CO3	S(3)	L(1)	M(2)	S(3)	S(3)
CO4	L(1)	M(2)	S(3)	M(2)	S(3)
CO5	M(2)	S(3)	L(1)	L(1)	M(2)
AVG	**2.2**	**2.4**	**2.2**	**2**	**2**

S –Strong (3), M-Medium (2), L- Low (1)

Elective Course					
DSE	**Course code: 511518**	**Optimization Techniques**	**T**	**Credits:5**	**Hours:5**

Unit -I

Objective 1	Explain the basic concepts of single and multivariable optimization methods

Classical Optimization Techniques: Introduction -Single-Variable Optimization - Multivariable Optimization with No Constraints - Saddle Point - Multivariable Optimization with Equality Constraints - Solution by Direct Substitution - Solution by the Method of Constrained Variation - Solution by the Method of Lagrange Multipliers - Multivariable Optimization with Inequality Constraints - Kuhn-Tucker Conditions.

Outcome	Understand the concepts of single and multivariable optimization methods and how to use inapplications.	**K3**

Unit II

Objective 2	Discuss about simplex. Revised simplex, two phase method and quadratic programming methods.

Linear Programming: Applications of Linear Programming - Standard Form of a Linear Programming Problem - Definitions and Theorems - Solution of a System of Linear Simultaneous Equations - Pivotal Reduction of a General System of Equations - Simplex Algorithm - Identifying an Optimal Point - Improving a Non optimal Basic Feasible Solution - Two Phases of the Simplex Method - Revised Simplex Method - Quadratic Programming.

Outcome2	Solve the problems in simplex. Revised simplex, two phase method and quadratic programming methods.	**K4**

Unit III

Objective 3	Demonstrate the various types of direct and indirect search methods of unconstraint optimization techniques.

Nonlinear Programming - Unconstrained Optimization Techniques: Introduction -Classification of Unconstrained Minimization - Direct Search Methods : Random Search Methods - Random Jumping Method - Random Walk Method - Random Walk Method with Direction Exploitation -Grid Search Method- Indirect Search (Descent) Methods: Gradient of a Function - Evaluation of the Gradient - Steepest Descent (Cauchy) .

Outcome3	Analyze the applications of various types of direct and indirect search methods of unconstraint optimization techniques.	**K4**

Unit IV

Objective 4	Introduce and classify the constraint optimization problems using various methods.

Nonlinear Programming - Constrained Optimization: Introduction -Characteristics of a Constrained Problem - Direct Methods:- Random Search Methods - Complex Method - Sequential Linear Programming - Indirect Methods- Transformation Techniques - Basic Approach of the Penalty Function Method - Interior Penalty Function Method - Convex Programming Problem.

Outcome4	Classify and solve the problems in the constraint optimization using various methods.	**K3**

Unit V

Objective 5	Analyse the concept of Gomory's and Branch and Bound techniques.

Integer Programming: Introduction - Integer Linear Programming - Graphical Representation - Gomory's Cutting Plane Method - Concept of a Cutting Plane - Gomory's Method for All-Integer Programming Problems - Gomory's Method for Mixed-Integer Programming Problems- Branch-and- Bound Method.

Outcome 5	Apply the concept of Gomory's and Branch and Bound techniques in various fields.	**K6**

Suggested Readings:

RAO S.S(1995)," *Engineering Optimization Theory and Practice(3rd Edition),* A Wiley-Interscience Publication,John Wiley & Sons, Inc., New York.

Taha, H.A. (2018). *Operations Research* (9th ed.). New Delhi: Pearson Education.

Hillier, F.S., Lieberman, G.J. (1989). *Introduction to Operation Research* (4th ed.). New York: Mc Graw Hill BookCompany.

Gillett, B.E. (1976). Operations research, A Computer Oriented Algorithmic Approach (TMH ed.). New Delhi.

Kanti Swarp, Gupta, P.K., Mohan, M. (2016), Operations Research(18th Edition), SultanChand and Sons.
Philips, D.T., Ravindra, A., Solbery, J. (1999). Operations Research. New York: Principles and Practice John Wileyand Sons.

Online resources

https://ocw.mit.edu/courses/15-093j-optimization-methods-fall-2009/

https://www.classcentral.com/course/swayam-optimization-from-fundamentals-23071

K1-Remember	*K2-Understand*	*K3- Apply*	*K4-Analyze*	*K5-Evaluate*	*K6-Create*

Course Designed by: Dr. R. Jeyabalan

Course Outcome VS Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S(3)	M(2)	S(3)	S(3)	M(2)	M(2)	L(1)	S(3)	S(3)	M(2)
CO2	M(2)	S(3)	S(3)	M(2)	S(3)	M(2)	S(3)	M(2)	M(2)	S(3)
CO3	S(3)	M(2)	M(2)	S(3)	M(2)	L(1)	S(3)	S(3)	S(3)	S(3)
CO4	M(2)	S(3)	S(3)	M(2)	S(3)	S(3)	M(2)	S(3)	S(3)	L(1)
CO5	S(3)	M(2)	S(3)	S(3)	S(3)	S(3)	M(2)	M(2)	S(3)	S(3)
AVG	2.6	2.4	2.8	2.6	2.6	2.2	2.2	2.6	2.8	2.4

S –Strong (3), M-Medium (2), L- Low (1)

Course Outcome VS Programme Specific Outcomes

CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S(3)	L(1)	M(2)	S(3)	S(3)
CO2	S(3)	M(2)	S(3)	S(3)	M(2)
CO3	S(3)	M(2)	M(2)	L(1)	S(3)
CO4	M(2)	S(3)	S(3)	M(2)	S(3)
CO5	S(3)	M(2)	M(2)	S(3)	S(3)
AVG	2.8	2	2.4	2.4	2.8

S –Strong (3), M-Medium (2), L- Low (1)

IV-Semester					
Core	**Course Code: 511401**	**Functional Analysis**	**T**	**Credits: 5**	**Hours: 5**

Unit-I		
Objective 1	To know the theory of normed spaces, in particular Banach spaces, and the theory of linear operators defined on them are the most highly developed parts of functional analysis	
Normed space - Banach space – Properties of normed spaces – Finite dimensional normed spaces and subspaces – Compactness and finite dimension – Linear operators – Bounded linear operators – Linear functional – Normed spaces of operators – Dual space.		
Outcome 1	Learners recognize the fundamental properties of normed spaces and construct examples of such spaces and understand the transformations between them	**K2**
Unit-II		
Objective 2	Studying Inner product spaces are a special type of normed spaces that connects the dot product and orthogonality to arbitrary vector spaces. It's the generalization of a Euclidean space	
Inner product space – Hilbert space – Properties – Orthogonal complements and direct sums – Orthonormal sets and sequences – Total orthonormal sets and sequences – Series related to orthonormal sets and sequences.		
Outcome 2	Students understand the notions of dot product and Hilbert space and apply the spectral theorem to the resolution of integral equations	**K3**
Unit-III		
Objective 3	Students will be able to know that the Hilbert adjoint operator mainly occurs in matrices and linear differential and integral equations. It extracts three different classes of operators, and it plays a key role in various applications in functional analysis	
Riesz's theorem – Hilbert adjoint operator – Self-adjoint, unitary and normal operators.		
Outcome 3	Having knowledge about Riesz's theorem, students can apply the concepts in quantum mechanics by totally reducing all the mathematical complexity out this down to a (real) finite dimensional vector space.	**K3**
Unit-IV		
Objective 4	To learn the more advanced theory of normed and Banach spaces in the form of three theorems (Hahn Banach, Unform Boundedness and Category theorems). These are the corner stones of the theory of Banach spaces.	
Zorn's Lemma - Hahn – Banach theorem - Adjoint operator – Reflexive spaces – Category theorem - Uniform boundedness theorem.		
Outcome 4	Knowing the concept of Hahn-Banach theorem students guarantee the separation of convex sets in normed spaces by hyperplanes	**K5**
Unit- V		
Objective 5	To get some awareness about a strong and weak convergence that yields greater flexibility and applications in sequences and series. Further, Spectral theory provides a powerful way to understand linear operators by decomposing the space on which they act into invariant subspaces on which their action is simple	
Strong and weak convergence – Convergence of sequences of operators and functionals – Open mapping theorem -Closed graph theorem – Spectral theory of linear operators in normed spaces – Spectral theory in finite dimensional normed spaces – basic concepts – Banach algebras.		
Outcome 5	Having the knowledge of Open Mapping and Closed Graph Theorem students be able to apply the practical applications that encounter the unbounded operators and connect the continuity of certain functions to a topological property of their graph	**K6**

Suggested Readings:

Kreyszig, E. (2011). *Introductory Functional Analysis with Applications*. John Wiley.
Goffman H.C., Fedrick, G. (1987). *First Course in Functional Analysis*. New Delhi: Prentice Hall of India.
Rudin, W. (1991). *Functional Analysis*. New Delhi: Tata McGraw Hill Publ. Co.
Simmons, G.F.(1963). *Introduction to Topology and Modern Analysis*. New York: McGraw Hill Inter. Book Co.
Somasundaram, D. (1994). *Functional Analysis*. Chennai: S. Viswanathan Pvt. Ltd.

Online resources

https://ocw.mit.edu/courses/18-102-introduction-to-functional-analysis-spring-2021/download/
https://ocw.mit.edu/courses/18-102-introduction-to-functional-analysis-spring-2009/pages/lecture-notes/
https://web.ma.utexas.edu/users/koch/M383C/

K1-Remember	*K2-Understand*	*K3- Apply*	*K4-Analyze*	*K5-Evaluate*	*K6-Create*

Course Designed by: Dr.R.RAJA

Course Outcome VS Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S (3)	M (2)	S (3)	S (3)	L (1)	L (1)	L (1)	L (1)	M (2)	M (2)
CO2	S (3)	L (1)	S (3)	S (3)	L (1)	L (1)	L (1)	L (1)	M (2)	M (2)
CO3	S (3)	M (2)	M (2)	S (3)	M (2)	L (1)	L (1)	L (1)	L (1)	M (2)
CO4	S (3)	L (1)	M (2)	S (3)	L (1)	L (1)	L (1)	L (1)	L (1)	M (2)
CO5	S (3)	M (2)	M (2)	S (3)	L (1)	L (1)	L (1)	L (1)	L (1)	M (2)
AVG	3.0	1.6	2.4	3.0	1.2	1.0	1.0	1.0	1.4	2.0

S –Strong (3), M-Medium (2), L- Low (1)

Course Outcome VS Programme Specific Outcomes

CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S (3)	M (2)	L (1)	S (3)	S (3)
CO2	S (3)	M (2)	L (1)	S (3)	S (3)
CO3	S (3)	M (2)	L (1)	S (3)	S (3)
CO4	S (3)	M (2)	L (1)	S (3)	S (3)
CO5	S (3)	M (2)	L (1)	S (3)	S (3)
AVG	**3.0**	**2.4**	**1.2**	**3.0**	**3.0**

S –Strong (3), M-Medium (2), L- Low (1)

IV-Semester					
Core	**Course code:511402**	**Probability and Statistics**	**T**	**Credits:5**	**Hours:5**

Unit-1

Objective 1	To introduce the basic concepts of probability and random variables.	
Probability set function-Conditional probability and independence–Random variables of discrete-type and continuous type- Distribution function and its properties - Expectation of a random variable-Moment generating function-Chebyshev's inequality.		
Outcome 1	This course aims at providing the required skill to apply statistical tools in engineering problems.	**K5**

Unit-2

Objective 2	Derive the probability density function of transformations of random variables and use these techniques to generate data from various distributions	
Two random variables- Joint density - Marginal probability density – Conditional distribution -Expectation and variance - Independence of two random variables - Mutual independence and pair-wise independence.		
Outcome 2	Construct the limiting distributions and its important results.	**K4**

Unit-3

Objective 3	To introduce the basic concepts of two-dimensional random variables.	
Discrete distributions-Bernoulli, binomial, and related distributions-Poisson distribution-Continuous distributions-Experimental, gamma, and chi-square normal and bivariate normal distributions.		
Outcome 3	Calculate probabilities, and derive the marginal and conditional distributions of bivariate random variables.	**K3**

Unit-4

Objective 4	To acquaint the knowledge of testing of hypothesis for small and large samples which plays an important role in real-life problems.	
Sample, Statistics, and Parameter concepts-Transformation of variables of discrete and continuous types- t and F distributions – Change of variable (and its extension), Order statistics-Distributions of order statistics and Moment-generating function.		
Outcome 4	Describe order statistics, its distributions, and moment-generating functions.	**K2**

Unit-5

Objective 5	To introduce the basic concepts of classifications of design of experiments which plays very important roles in the field of agriculture and statistical quality control.	
Distributions of the sample mean and sample variance-Expectation of the function of random variables-Limiting distributions-Convergence in probability and in distribution-Limiting M.G.F-Central limit theorem-Important results on limiting distributions.		
Outcome 5	Solve the distributions of sample mean, variance, and central limit theorem.	**K5**

Suggested Readings:

Hogg, Craig, Mckean, J. (2018).*Introduction to Mathematical Statistics*(7th ed.).Pearson Education.
Chow Y.S. Teicher, H. (1988). *Probability Theory*. Berlin: Springer Verlag. Chung,K.L.(1974).
A course in Probability. New York: Academic Press. Durrett,
R.(1996).Probability:*TheoryandExamples*(2nd ed.).NewYork: DuxburyPress.

Online resources:

https://nptel.ac.incourser.org/learn/probability-statistics

K1-Knowledge	K2-Understanding	K3-Apply	K4-Analyze	K5-Evaluate	K6-Create

Course designed by: Dr. J. Vimala

Course Outcome VS Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M(2)	L(3)	S(3)	M(2)	M(2)	S(3)	M(2)	S(3)	M(2)	L(1)
CO2	L(1)	M(2)	S(3)	L(1)	M(2)	S(3)	M(2)	M(2)	M(2)	L(1)
CO3	M(2)	S(3)	S(3)	M(2)	L(1)	M(2)	M(2)	L(1)	M(2)	L(1)
CO4	M(2)	M(2)	S(3)	S(3)	M(2)	S(3)	M(2)	M(2)	L(1)	L(1)
CO5	M(2)	S(3)	M(2)	S(3)	M(2)	S(3)	M(2)	M(2)	S(3)	M(2)
AVG	**1.8**	**2.6**	**2.8**	**2.2**	**1.8**	**2.8**	**2**	**2**	**2**	**1.2**

S-Strong(3), M-Medium(2), L-Low(1)

Course Outcome VS Programme Specific Outcomes

CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S(3)	S(3)	L(1)	M(2)	M(2)
CO2	M(2)	L(1)	M(2)	L(1)	M(2)
CO3	M(2)	S(3)	M(2)	S(3)	M(2)
CO4	M(2)	M(2)	M(2)	M(2)	M(2)
CO5	M(2)	L(1)	M(2)	M(2)	M(2)
AVG	**2.2**	**2**	**1.8**	**2**	**2**

S-Strong(3), M-Medium(2), L-Low(1)

IV - Semester					
Core	**Course code: 511403**	**Graph Theory**	**T**	**Credits:5**	**Hours:5**

Unit -I

Objective 1	Introduce the fundamental concepts of graph theory, in a sense of some of its modern applications. We develop useful properties of connection, paths and cycles.

Graphs and Simple Graphs Subgraphs – Graph isomorphisms – Incidence and Adjacency matrices –Vertex degrees – Paths and Connection –Cycles – Trees- Cut edge and Bonds– Cut vertices – Cayley's Formula.

Outcome1	Understand the basic concept of graphs, directed graphs, and weighted graphs and able to present a graph by matrices. Also understand the properties of trees and able to find a minimal spanning tree for a given weighted graph.	**K2**

Unit II

Objective 2	Define and characterize Eulerian graphs and study Hamiltonian graphs. Also to cover a variety of different problems in graph theory.

Connectivity – Blocks – Euler tours – Hamiltonian cycles-Applications-The Connector Problem.

Outcome2	Understand Eulerian and Hamiltonian graphs.	**K3**

Unit III

Objective 3	Discuss independence of vertices in a graph and discuss dominance of vertices in a graph as well as study matchings in graphs, especially matchings in bipartite graphs.

Matchings - Matchings and coverings in Bipartite graphs – Perfect matchings – Independent sets –Ramsey's theorem – Turan's theorem.

Outcome3	Understand and characterize every maximum matching in terms of M-augmenting paths. Also understand Hall's marriage theorem for bipartite graphs and the deficiency of matchings of bipartite graphs.	**K4**

Unit IV

Objective 4	Define the complete k-partite graph and Turan's graphs and study Brook's theorem and related coloring algorithms. Also present and prove the Five color theorem for planar graphs.

Colourings -Edge chromatic number – Vizing's theorem – Chromatic number – Brook's theorem –Hajo's Conjecture – Chromatic polynomials.

Outcome4	Understand the concept of chromatic number of a graph and edge coloring of graph(s) via Vizing's theorem.	**K5**

Unit V

Objective 5	Discuss the meaning of planar embedding of planar graphs and present Euler's formula for planar graphs and examine its consequences.

Plane and planar graphs – Dual graphs – Euler's formula – The five colour theorem and Four Colour Conjecture.

Outcome 5	Understand a combinatorial characterization of planar graphs interms of abstract duality.	**K6**

Suggested Readings:

Bondy J. A. Murthy U.S.R. (1982). *Graph Theory with Applications*. The Macmillan Press Ltd.

Balakrishnan.R & Ranganathan.K(2000).*A Text Book Of Graph Theory*, Springer. Bela

Bollobas. (1998). *Modern Graph Theory*. Springer, Science & Business Media.

Douglas West, B. (2011). *Introduction to Graph Theory* (2nd ed.). Pearson Prentice Hall.

Foulds, L. R. (1933). *Graph Theory Application*. Chennai: Narosa Publ. House.

Harary, F. (1969). *Graph Theory*. Addison Wesely Pub. Co.

Jean Calude Fournier. (2009). *Graph Theory and Applications*. Wiley-ISTE.

Jonathan Gross, L., Jay Yellen, (2010). *Hand Book of Graph Theory* (2nd ed.). CRC Press.

Online resources

https://ocw.mit.edu/courses/18-217-graph-theory-and-additive-combinatorics-fall-2019/

https://onlinecourses.swayam2.ac.in/cec20_ma03/preview

https://ocw.mit.edu/courses/18-217-graph-theory-and-additive-combinatorics-fall-2019/

https://nptel.ac.in/courses/128106001

K1-Knowledge	K2-Understanding	K3-Apply	K4-Analyze	K5-Evaluate	K6-Create

Course Designed by: Dr. S. Amutha

Course Outcome VS Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S (3)	M (2)	S (3)	M (2)	S (3)	S (3)	S (3)	M (2)	S (3)	S (3)
CO2	M (2)	L (1)	S (3)	L (1)	S (3)	S (3)	S (3)	M (2)	S (3)	S (3)
CO3	S (3)	M (2)	S (3)	M (2)	S (3)	S (3)	S (3)	L (1)	S (3)	S (3)
CO4	L (1)	M (2)	S (3)	M (2)	S (3)	S (3)	S (3)	M (2)	S (3)	S (3)
CO5	S (3)	M (2)	M (2)	S (3)	S (3)	S (3)	M (2)	S (3)	S (3)	S (3)
AVG	**2.4**	**1.8**	**2.8**	**2**	**3**	**3**	**2.8**	**2**	**3**	**3**

S –Strong (3), M-Medium (2), L- Low (1)

Course Outcome VS Programme Specific Outcomes

CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S (3)	S (3)	L (1)	M (2)	L (1)
CO2	S (3)	S (3)	L (1)	M (2)	L (1)
CO3	S (3)	S (3)	L (1)	M (2)	L (1)
CO4	S (3)	S (3)	L (1)	M (2)	L (1)
CO5	S (3)	S (3)	L (1)	M (2)	L(1)
AVG	**3**	**3**	**1**	**2**	**1**

S –Strong (3), M-Medium (2), L- Low (1)

IV - Semester					
Core	**Course code: 511404**	**Measure And Integration**	**T**	**Credits:5**	**Hours:5**

Unit -I

Objective 1	Focus on the definition of Lebesgue's outer measure	
Measure on the Real line – Lebesgue's Outer measure – Measurable sets – Regularity – Abstract Measure Spaces – Measures and Outer Measures - Extension of a Measure- **Measure on the Real Line** – Measurable functions – Borel and Lebesgue's Measurability.		
Outcome1	Understand better the definition of lebesgue's outer measure.	**K2**

Unit II

Objective 2	Aim to introduce Riemann and Lebesgue Integrals	
Integration of Functions of a Real Variable – Integration of Non–negative Functions – The General Integral – Integration of series -Riemann and Lebesgue integrals**.**		
Outcome 2	Know the basic theory of Riemann and Lebesgue Integral.	**K2**

Unit III

Objective 3	Introducing different types of derivatives	
The Four Derivatives- Continuous non Differentiable Functions- Lebesgue's Differentiation Theorem- Differentiation and Integration-The Lebesgue Set.		
Outcome3	Understand the concept of types of derivatives.	**K4**

Unit IV

Objective 4	**Aim to Prove Radon-Nikodym theorem**	
Signed Measures and their Derivatives – Signed Measures and the Hahn Decomposition – TheJordan Decomposition – the Radon – Nikodym Theorem.		
Outcome4	Understand the proof of Radon-Nikodym theorem.	**K3**

Unit V

Objective 5	To Illustrate how general methods of Fubini's theorem can be used.	
Measure and Integration in a Product Space – Measurability in a Product Space – The ProductMeasure and Fubini's Theorem.		
Outcome5	To Consolidate earlier knowledge of measurability in a product space to prove Fubini'stheorem.	**K4**

Suggested Readings:

De Barra, G. (2011). *Measure theory and Integration*. Wiley Eastern, New Delhi.

Gerald Folland, B. (2012). *Real Analysis, Modern Techniques and their Applications*. Secod Edition, Wiley InderScience Series of Texts.

Jain, P.K. and Gupta, V.P. (2000). *Lebesgue Measure and Integration*. New Age Int. (P) Ltd., New Delhi.

Royden, H.L. (1993). *Real Analysis*. Mc Millian Publ. Co, New York.

Rudin, W. (1966). *Real and Complex Analysis*. Tata McGraw Hill Publ. Co. Ltd., New Delhi.

Serge Lang. (1993). *Real and Functional Analysis*. Springer.

Online resources:

http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics, http://www.opensource.org, www.mathpages.com

K1-Remember	*K2-Understand*	*K3- Apply*	*K4-Analyze*	*K5-Evaluate*	*K6-Create*

Course Designed by: Dr. B. Sundaravadivoo

Course Outcome VS Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	L(1)	S(3)	M(2)	M(2)	S(3)	M(2)	S(3)	M(2)	M(2)	L(1)
CO2	L(1)	M(2)	S(3)	M(2)	S(3)	S(3)	S(3)	M(2)	M(2)	L(1)
CO3	M(2)	L(1)	M(2)	S(3)	S(3)	S(3)	S(3)	M(2)	M(2)	M(2)
CO4	L(1)	M(2)	S(3)	S(3)	S(3)	M(2)	S(3)	M(2)	S(3)	L(1)
CO5	M(2)	L(1)	S(3)	S(3)	S(3)	M(2)	S(3)	M(2)	S(3)	M(2)
AVG	**1.4**	**1.8**	**2.6**	**2.6**	**3**	**2.4**	**3**	**2**	**2.4**	**1.4**

S –Strong (3), M-Medium (2), L- Low (1)

Course Outcome VS Programme Specific Outcomes

CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	L(1)	S(3)	M(2)	M(2)	S(3)
CO2	L(1)	M(2)	S(3)	M(2)	S(3)
CO3	L(1)	M(2)	M(2)	M(2)	S(3)
CO4	L(1)	M(2)	M(2)	S(3)	S(3)
CO5	M(2)	S(3)	S(3)	S(3)	S(3)
AVG	**1.2**	**2.4**	**2.4**	**2.4**	**3**

S –Strong (3), M-Medium (2), L- Low (1)

Non-Major Elective Course					
NME	**Course code:**	**Resource Management Techniques**	**T**	**Credits:2**	**Hours:3**

Unit-1

Objective 1	Emphasize the application of Operations Research for solving business problems.	
Linear programming: Formulations and graphical solutions to linear programming problems –Simplex method – Degeneracy – Unbounded – Infeasible solution – Method of penalty – Two phase method.		
Outcome 1	Solve linear programming issues using a variety of techniques.	**K3**

Unit-2

Objective 2	Know and understand common and important business problems.	
Duality–Primalanddualcomputations–Dualsimplexmethod–Transportation problem–Assignment problem.		
Outcome 2	Understand how management system models operate.	**K2**

Unit-3

Objective 3	Study the various phase of project scheduling.	
Integer programming: Pure and mixed integer programming problems– Gomary cutting–Plane method –Branch and bound techniques.		
Outcome 3	Use quantitative OR techniques to solve accounting problems.	**K4**

Unit-4

Objective 4	Develop the problem modeling and solving skills and learn how to make intelligent business decisions from the point of view of optimization.	
Project scheduling-PERT-CPM: Phase of project scheduling–Arrow diagram–CPM–Probability and cost considerations in project scheduling–Crashing of networks.		
Outcome 4	Be conversant with the numerous management operations and management accounting issues that are present in the business world of today.	**K5**

Unit-5

Objective 5	Introduce queuing theory and its models.	
Queuing Theory: Queuing system – Characteristics of queuing system – Classification of queues –M/M/1 and M/M/C queuing models. Inventory management: Inventory control – ABC analysis –Economic lot size problems–EOQ with uniform demand and shortages–Limitations of inventories–Buffer stock–Determination of buffer stocks.		
Outcome 5	Learn the computer modeling and analytical skills required to solve and comprehend these issues.	**K2**

Suggested Readings:

Swarup ,K. Gupta, P.K. Man Mohan.(2016). *Operations Research*.(18th ed.).Sultan Chand.

Fredericks Hillier, S.Gerold Lieberman, J.Bodhibrata Nag, Preetam Basu.(2013). *Introduction to Operation Research*. McGraw Hill Education Pvt Ltd.

Hamdy Taha, A.(1992). *Operations Research: An Introduction*.(5th ed.).Macmillan.

Pradeep Prabhakaran Pai.(2012).*Operation Research, Principle and Practice*. Oxford University Press.

Online resources:
https://nptel.ac.in

K1-Remember	*K2-Understand*	*K3- Apply*	*K4-Analyze*	*K5-Evaluate*	*K6-Create*

Course designed by: Dr. J. Vimala

Course Outcome VS Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	L(1)	L(3)	M(2)	M(2)	M(2)	S(3)	L(1)	S(3)	L(1)	L(1)
CO2	L(1)	M(2)	S(3)	L(1)	M(2)	S(3)	M(2)	M(2)	M(2)	L(1)
CO3	M(2)	M(2)	S(3)	M(2)	L(1)	S(3)	M(2)	L(1)	M(2)	M(2)
CO4	S(3)	M(2)	S(3)	S(3)	M(2)	S(3)	M(2)	M(2)	L(1)	L(1)
CO5	M(2)	S(3)	M(2)	S(3)	M(2)	S(3)	M(2)	M(2)	S(3)	L(1)
AVG	**1.8**	**2.4**	**2.6**	**2.2**	**1.8**	**3**	**1.8**	**2**	**1.8**	**1.2**

S-Strong(3), M-Medium(2), L-Low(1)

Course Outcome VS Programme Specific Outcomes

CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S(3)	S(3)	S(3)	M(2)	M(2)
CO2	M(2)	L(1)	M(2)	L(1)	M(2)
CO3	L(1)	S(3)	S(3)	S(3)	L(1)
CO4	L(1)	M(2)	M(2)	S(3)	M(2)
CO5	M(2)	S(3)	M(2)	M(2)	S(3)
AVG	**1.8**	**2.4**	**2.4**	**2.2**	**2**

S-Strong(3), M-Medium(2), L-Low(1)

Non-Major Elective Course					
NME	**Course Code:**	**Methods of Mathematical Physics**	**T**	**Credits: 2**	**Hours: 3**
Unit –I					
Objective 1	To understand the boundary value problems and to analyze and solve essential concepts such as eigenvalues, eigen functions and the Sturm-Liouville problem.				
Boundary value problems and series solution – Examples of boundary value problems – Eigen values, eigen functions and the Sturm-Liouville problem – Hermitian operators, their eigen values and eigen functions.					
Outcome 1	Apply eigenvalue and eigen function methods to solve diverse boundary value problems in mathematical and scientific contexts.				**K3**
Unit II					
Objective 2	To provide better understanding of special functions like Bessel function, Legendre polynomials and to develop skills to solve mathematical problems involving these functions in science and engineering.				
Bessel functions – Bessel functions of the second kind - Hankel functions – Spherical Bessel functions – Legendre polynomials – Associated Legendre polynomials and spherical harmonics.					
Outcome 2	Enable students to tackle complex mathematical and physical problems in the context of Bessel functions and spherical hormonics.				**K2**
Unit III					
Objective 3	To introduce mathematical concepts focusing on special polynomials, Gamma function and Dirac Delta function and to develop knowledge on these functions and the significance.				
Hermite polynomials – Laguerre polynomials – The Gamma function – The Dirac Delta function.					
Outcome 3	Improve analytical skills to apply Hermite and Laguerre polynomials in real life problems and to solve them using Gamma and Dirac Delta function.				**K3**
Unit IV					
Objective 4	To learn about Green's function in higher dimensions and their application in solving complex problems and to gain knowledge in Fourier transform methods.				
Green's function in higher dimensions – Green's function for one dimensional problems – eigen function expansion of Green's function – Fourier transform method of construction of Green's function.					
Outcome 4	Enable students to proficiently construct and apply Green's function in higher dimensional problems and provide them a better understanding in Fourier transform method.				**K1**
Unit V					
Objective 5	To learn more about applying Green's function in Poisson's equation and solution of electrostatic boundary value problems. Also to study about wave equation and their role in quantum mechanical scattering problem.				
Green's function in higher dimensions – Green's function for Poisson's equation and a formal solution of electrostatic boundary value problems – Wave equation with source – quantum mechanical scattering problem.					
Outcome 5	Empower students to advance in research and problem solving in areas where Green's function plays a crucial role especially in wave equation and quantum mechanics.				**K2**

Suggested Readings:

Chattopadhyay, P.K. (1990). *Mathematical Physics*. New Age International (P) Ltd. Publishers.

George Arfken, B. Hans Weber, J. And Frank Harris, E. (2013). *Mathematical Methods for Physicists*, Oxford, Uk: Academic Press, Elsevier.

Riley, K.F. Hobson, M.P. And Bence, S.J. (2006). Mathematical *Methods for Physics and Engineering*. UK: Cambridge University Press.

Svozil, K. (2019). *Mathematical Methods of Theoretical Physics*. (6th Ed.). Funzl.

Online resources					
https://nptel.ac.in/courses/115105097 https://onlinecourses.nptel.ac.in/noc21_ma48/preview https://www.coursera.org/learn/quantum-physics					
K1-Remember	*K2-Understand*	*K3- Apply*	*K4-Analyze*	*K5-Evaluate*	*K6-Create*
Course Designed by: Dr. R. RAJA					

Course Outcome VS Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M(2)	M(2)	S(3)	S(3)	L(1)	S(3)	L(1)	M(2)	L(1)	L(1)
CO2	M(2)	S(3)	S(3)	S(3)	M(2)	M(2)	L(1)	L(1)	L(1)	L(1)
CO3	S(3)	S(3)	S(3)	S(3)	L(1)	M(2)	L(1)	L(1)	L(1)	L(1)
CO4	S(3)	S(3)	S(3)	M(2)	M(2)	M(2)	L(1)	L(1)	M(2)	L(1)
CO5	S(3)	S(3)	S(3)	S(3)	M(2)	M(2)	L(1)	L(1)	M(2)	L(1)
AVG	**2.6**	**2.8**	**3**	**2.8**	**1.6**	**2.2**	**1**	**1.2**	**1.8**	**1**

S –Strong (3), M-Medium (2), L- Low (1)

Course Outcome VS Programme Specific Outcomes

CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M(2)	S(3)	L(1)	M(2)	M(2)
CO2	S(3)	S(3)	M(2)	S(3)	L(1)
CO3	M(2)	L(1)	S(3)	S(3)	M(2)
CO4	L(1)	S(3)	M(2)	L(1)	S(3)
CO5	M(2)	L(1)	M(2)	M(2)	L(1)
AVG	**2**	**2.2**	**2**	**2.2**	**1.8**

S –Strong (3), M-Medium (2), L- Low (1)

Non-Major Elective Course					
NME	**Course Code:**	**Classical Mechanics**	**T**	**Credits: 2**	**Hours:3**
Unit –I					
Objective 1	To know how to impose constraints on a system to simplify the methods to be used in solving physics problems				
Constraints: Classification of constraints - Principal of virtual work. D'Alembert's principle and Lagrange's Equations-Velocity dependent potentials and the dissipation function - Simple application problems (D'Alembert's, Lagrangian and Hamilton's).					
Outcome 1	By Knowing the modern dynamics of Lagrangian, Students be able to define the generalised coordinates, generalised velocities, generalised force etc.,				**K3**
Unit II					
Objective 2	To explain the concepts of generalized coordinates and to introduce the formulation of Lagrangian and Hamiltonian Mechanics				
Variational principles and Lagrange's equations: Hamilton's principle -Derivation of Lagrange's equations from Hamilton's principle - Extension of Hamilton's principle to non-holonomic systems-Variational principle formulation - Conservation theorems and symmetry properties - Energy function and conservation of energy.					
Outcome 2	Understand the essence of variational principles and apply the basic facts about Hamiltonian systems into two research fields viz., elasticity and conservation laws and reciprocity				**K4**
Unit III					
Objective 3	To know what central, conservative and central-conservative forces mathematically understand the conservative theorems of energy, linear momentum and angular Momentum.				
The Hamilton equations of motion: Legendre transformation and the Hamilton's equations of motion-Cyclic coordinates and conservation theorems-Routh's procedure - Derivation of Hamilton's equations from a variational principle-The principle of least action.					
Outcome 3	Apply the concepts of Legendre transformations and the Hamilton's equations of motion, cyclic coordinates and Conservation Theorems, Hamilton's equations from Hamilton's principle, the principle of least action.				**K5**
Unit IV					
Objective 4	To understand the notion of Poisson brackets, canonical transformations				
Canonical transformations: The equations and examples of canonical transformations - The harmonic oscillator problem - Poisson brackets and other canonical invariants - Liouville's theorem. Hamilton Jacobi Theory and Action -Angle Variables – The Hamilton Jacobi equation for Hamilton's principal function.					
Outcome 4	Learn Canonical transformations with examples of harmonic oscillator, Poisson's brackets, Equations of motion and conservation theorems in the Poisson Bracket formulation.				**K6**
Unit V					
Objective 5	To find the linear approximation to any dynamical system near equilibrium and know how to derive and solve the wave equation for small oscillations and to establish that Kepler's laws are just consequences Newton's laws of gravitation and that of motion				
Hamilton-Jacobi theory: The Hamilton-Jacobi equation for Hamilton's principal function - The Harmonic oscillator problem - separation of variables in the Hamilton-Jacobi equation - Ignorable coordinates and the Kepler problem, Periodic motion – Perturbations and the Kolmogorov-Arnold Moser theorem.					
Outcome 5	Develop the knowledge of modern mechanics like Hamiltonian formulations of classical mechanics and their applications in appropriate physical problems.				**K3**

Suggested Readings:

Goldstein, H. (2018). *Classical Mechanics*. (2nd ed.). New Delhi: Narosa Publishing Home.
Chandra, S. (2009). *Classical Mechanics: A Textbook*. UK: Alpha Science International.
John Taylor, R. (2005). *Classical Mechanics*. (2nd ed.). Sausalito, California: University Science Books.
Panat, P.V. (2013). *Classical Mechanics*. New Delhi: Narosa Publishing Home.
Rana, N.C. and Joag, P.S. (2015). *Classical Mechanics*. New Delhi: Tata Mc-Graw Hill Publishing Company Limited.
Synge J.L. And Griffth, B.A. (1970). *Principles Of Mechanics*. New York: Mcgraw Hill Book Co.

Online resources

1. https://archive.nptel.ac.in/courses/115/106/115106123/
2. https://www.coursera.org/specializations/introduction-to-mechanics
3. https://www.coursera.org/learn/engineering-mechanics-statics

K1-Remember	*K2-Understand*	*K3- Apply*	*K4-Analyze*	*K5-Evaluate*	*K6-Create*

Course Designed by: Dr.R.RAJA

Course Outcome VS Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S (3)	M (2)	S (3)	S (3)	L (1)	M (2)	L (1)	L (1)	S (3)	S (3)
CO2	S (3)	L (1)	S (3)	S (3)	M (2)	M (2)	L (1)	M (2)	S (3)	S (3)
CO3	M (2)	L (1)	S (3)	S (3)	M (2)	L (1)	M (2)	L (1)	M (2)	S (3)
CO4	M (2)	L (1)	M (2)	S (3)	M (2)	M (2)	L (1)	L (1)	M (2)	S (3)
CO5	S (3)	M (2)	L (1)	S (3)	L (1)	L (1)	M (2)	L (1)	M (2)	S (3)
AVG	**2.6**	**1.4**	**2.4**	**3.0**	**1.6**	**1.6**	**1.4**	**1.2**	**2.4**	**3.0**

S –Strong (3), M-Medium (2), L- Low (1)

Course Outcome VS Programme Specific Outcomes

CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M (2)	S (3)	S (3)	M (2)	M (2)
CO2	M (2)	M (2)	S (3)	M (2)	L (1)
CO3	S (3)	S (3)	S (3)	M (2)	S (3)
CO4	S (3)	M (2)	S (3)	S (3)	S (3)
CO5	M (2)	M (2)	S (3)	M (2)	S (3)
AVG	**2.4**	**2.4**	**3.0**	**2.2**	**2.4**

S –Strong (3), M-Medium (2), L- Low (1)

Non Major Elective course					
NME	**Course code:**	**Discrete Mathematics**	**T**	**Credits:2**	**Hours:3**

Unit -I

Objective 1	To have an understanding of the theory of inference for the statement of calculus.

Mathematical Logic: Statements and notation – Connectives - Normal forms – The theory of inferencefor the statement calculus – The predicate calculus – Inference theory and predicate calculus.

Outcome1	Develop Problem-solving skills.	**K1**

Unit II

Objective 2	To discuss the basic concepts of sets, Notation, Inclusion, Equality of sets and functions.

Set theory : Sets – Basic concepts – Notation – Inclusion and equality of sets – The power set – Relations and ordering – Properties – relation matrix and graph of a relation – Partition – Equivalence and compatibility relations – Composition – Partial ordering – Partially ordered set - Functions – Definition – Composition – Inverse – Binary and n-ary operations – Characteristic function – Hashing function.

Outcome2	Enhance Analytical skills.	**K3**

Unit III

Objective 3	To know and understand the concept of Groups, Co-sets and Lagrange's theorem and Normal subgroups.

Algebraic structures - Algebraic systems: Examples and general properties – semigroups and monoids: Definitions and examples – Homomorphism of semigroups and monoids – Sub semigroups and sub monoids – Groups: Definitions and examples – Cosets and Lagrange's theorem – Normal subgroups– Algebraic systems with two binary operations.

Outcome3	Learn Algebraic structures.	**K4**

Unit IV

Objective 4	To understand the concept of basic graph theory notions and to apply with computer applications.

Graph theory: Basic concepts – Definitions – Paths – Reachability and connectedness – Matrix representation of graphs – Trees.

Outcome 4	Define and recognize the basic concepts of graph theory.	**K2**

Unit V

Objective 5	Develop the probability distributions and mathematical expectations.

Finite probability – Probability distributions – Conditional probability – independence – Bayes' theorem – Mathematical expectation.

Outcome5	Identify the concepts of finite probability.	**K5**

Suggested Readings:

Tremblay, J.P., Manohar, R. (2017). *Discrete Mathematical Structures with Applications to Computer Science*. NewYork: Mc-Graw Hill Book Company. (Unit I to IV).

Judith Gersting, L. (2003). *Mathematical Structures for Computer Science*. (5th ed.). W.H.Freeman and Company.(Unit V)

Kolman, B., Roberty Busby, C., Sharn Cutter Ross, (2013). *Discrete Mathematical Structures*. (6th ed.). PearsonEducation.

Ramasamy, V., (2006). *Discrete Mathematical Structures with application to Combinatorics*. Universities Press

Online resources

https://ocw.mit.edu/courses/18-310-principles-of-discrete-applied-mathematics-fall-2013/

https://www.classcentral.com/course/swayam-discrete-mathematics-5217

K1-Remember	***K2-Understand***	***K3- Apply***	***K4-Analyze***	***K5-Evaluate***	***K6-Create***

Course Designed by: Dr. N. Anbazhagan

Course Outcome VS Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S(3)	S(3)	S(3)	M(2)	S(3)	S(3)	S(3)	L(1)	S(3)	S(3)
CO2	S(3)	M(2)	S(3)	L(1)	M(2)	S(3)	S(3)	S(3)	S(3)	S(3)
CO3	S(3)	S(3)	M(2)	S(3)	S(3)	S(3)	S(3)	S(3)	S(3)	M(2)
CO4	S(3)	S(3)	L(1)	S(3)	S(3)	M(2)	S(3)	S(3)	S(3)	S(3)
CO5	S(3)	S(3)	S(3)	S(3)	S(3)	S(3)	M(2)	S(3)	M(2)	S(3)
AVG	**3**	**2.8**	**2.4**	**2.4**	**2.8**	**2.8**	**2.8**	**2.6**	**2.8**	**2.8**

S –Strong (3), M-Medium (2), L- Low (1)

Course Outcome VS Programme Specific Outcomes

CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S(3)	S(3)	M(2)	S(3)	S(3)
CO2	S(3)	L(1)	S(3)	S(3)	M(2)
CO3	S(3)	M(2)	S(3)	S(3)	S(3)
CO4	S(3)	M(2)	S(3)	S(3)	L(1)
CO5	S(3)	S(3)	S(3)	S(3)	S(3)
AVG	**3**	**2.2**	**2.8**	**3**	**2.4**

S –Strong (3), M-Medium (2), L- Low (1)

Non- Major Elective course					
NME	**Course code:**	**Descriptive Statistics**	**T**	**Credits:2**	**Hours:3**

Unit -I		
Objective 1	To understand the Scope, Functions, limitations, uses and misuses of statistics.	
Origin - Scope – Functions, limitations, uses and misuses of statistics – Classification and tabulationof data - Diagrammatic and graphical representation of data.		
Outcome1	Know the visual summary of Diagrammatic and graphical representation of data.	**K1**

Unit II		
Objective 2	To acquire knowledge of measure of central tendency.	
Measure of central tendency - Measures of dispersion - Relative measures of dispersion - skewness and kurtosis - Lorenz curve.		
Outcome2	Know when it is appropriate to use each measure of central tendency.	**K3**

Unit III		
Objective 3	To acquaint students with some basic concepts in Probability.	
Elementary probability space - Sample space - discrete probability, independent events - Mathematical and statistical probability -Axiomatic approach to probability - Addition and multiplication theorems - conditional probability – Bayes' theorem - Simple problems..		
Outcome3	Know the concept of Baye's theorem.	**K4**

Unit IV		
Objective 4	To discuss relative measures of dispersion, skewness and kurtosis.	
Random variables - Discrete and continuous random variables - Distribution function – probability mass function and probability density function of a random variable – Expectation of a random variable - evaluation of standard measures of location, dispersion, skewness and kurtosis.		
Outcome4	Know the discrete and continuous random variables.	**K5**

Unit V		
Objective 5	Identify the relationship between two variables.	
Simple linear correlation and regression - Scatter diagram - Karl Pearson's correlation co-efficientand its properties - Spearman's correlation co-efficient. Regression equations– fitting of regression equations - regression coefficients and its properties.		
Outcome 5	Know how to solve the problem using Karl Pearson's and Spearman's correlation coefficient.	**K6**

Suggested Readings:

Gupta, S.C. and Kapoor, V.K. (2000). *Fundamentals of Mathematical Statistics*. (10th ed.). New Delhi: SultanChand and Sons.

Goon, A.M. Gupta, M.K. and Dasgupta, B. (2008). *Fundamentals of Statistics, Volume-I*. Calcutta: World Press Ltd.

Hogg, R.V. McKean, J.W. and Craig, A.T. (2013). *Introduction to Mathematical Statistics*. (7th ed.). Pearson Education Ltd.

Spiegel, M.R. Schiller, J. and Srinivasan, R.A. (2012). *Probability and Statistics, Schaum's Outline Series*. (4th ed.).New Delhi: McGraw- Hill Publishing Company.

Online resources

https://ocw.mit.edu/courses/18-650-statistics-for-applications-fall-2016/resources/lecture-1-introduction-to-statistics/

https://onlinecourses.swayam2.ac.in/cec21_ma01/preview

K1-Remember	*K2-Understand*	*K3- Apply*	*K4-Analyze*	*K5-Evaluate*	*K6-Create*

Course Designed by: Dr. N. Anbazhagan

Course Outcome VS Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S(3)	S(3)	M(2)	S(3)	M(2)	S(3)	S(3)	S(3)	S(3)	L(1)
CO2	S(3)	M(2)	S(3)	M(2)	S(3)	S(3)	S(3)	S(3)	S(3)	S(3)
CO3	S(3)	S(3)	L(1)	S(3)	S(3)	S(3)	M(2)	S(3)	S(3)	S(3)
CO4	M(2)	S(3)	S(3)	S(3)	M(2)	S(3)	S(3)	S(3)	S(3)	S(3)
CO5	S(3)	S(3)	S(3)	S(3)	S(3)	M(2)	S(3)	S(3)	S(3)	S(3)
AVG	**2.8**	**2.8**	**2.4**	**2.8**	**2.6**	**2.8**	**2.8**	**3**	**3**	**2.6**

S –Strong (3), M-Medium (2), L- Low (1)

Course Outcome VS Programme Specific Outcomes

CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S(3)	S(3)	S(3)	L(1)	M(2)
CO2	S(3)	S(3)	S(3)	M(2)	S(3)
CO3	M(2)	L(1)	S(3)	S(3)	S(3)
CO4	S(3)	S(3)	S(3)	M(2)	S(3)
CO5	S(3)	S(3)	M(2)	S(3)	S(3)
AVG	**2.8**	**2.6**	**2.8**	**2.2**	**2.8**

S –Strong (3), M-Medium (2), L- Low (1)

Non-Major Elective Course					
NME	**Course code:**	**Biostatistics**	**T**	**Credits:2**	**Hours:3**

Unit -I

Objective 1	Provide an introduction to the basic concepts of statistical ideas and methods that aims to equip students to carry out common statistical procedures and to follow statistical reasoningin their fields of study.

Introduction to biostatistics: Numerical summary measures-measures of Central tendency- Mean, Median, Mode. Measures of Dispersion: Range, Inter-Quartile Range, Standard Deviation and Coefficient of Variation. Grouped data-Grouped mean, grouped variance, Chebyshev's Inequality.

Outcome1	One can classify the types of data and find the average of a data set.	**K2**

Unit II

Objective 2	Realize and offer references of types of data.

Data presentation – Types of numerical data – Frequency distributions, relative frequency. Graphs- Bar Charts, Histograms, Frequency polygons, One –way scatter Plots, Box plots, Two-way scatter plots, Line graphs.

Outcome2	Give a quick visual summery of the distribution by the polygon shape.	**K3**

Unit III

Objective 3	Comprehend and clarify relevant ratios while comparing two populations

Confidence interval - Standard deviation, Gaussian distribution, confidence interval of a mean, Survival Curves. Comparing groups with confidence intervals-Confidence interval of a difference between means, Confidence interval for the difference or ratio of two proportions.

Outcome3	Calculate a measure of the relationship between two variables.	**K4**

Unit IV

Objective 4	Identify the strength and direction of a linear relationship between two variables.

Correlation Coefficient-Regression Testing of Significance-Large Samples-Small Samples**.**

Outcome4	Measure the degree of certainity and uncertainity in a sampling method.	**K5**

Unit V

Objective 5	Understand and infer results from Analysis of Variance.

Chi-Square distribution and Goodness of Fit- Analysis of Variance –Two way Classification.

Outcome5	Analyze the two way classification and chi-square distribution.	**K5**

Suggested Readings:

Daniel, W.W. (2008). Bio-Statistics: A Foundation for Analysis in the Health Science. John Wiley & Sons, Inc.

S.C.Srivastava,Sangya Srivastava(2009), *Fundamental of Statistics*,Anmol Publications Pvt.Ltd, New Delhi.Campbell, R.C. (1989). *Statistics for Biologists*. (3rd ed.). Cambridge University Press, London.

Glantz, S.A. (2012). *Primer of Bio-Statistics*. (7th ed.). McGraw-Hill Professional Publishing, USA.

Sokal, R.R. and Rohlf, F.J. (1995). *Biometry: The Principles and Practice of Statistics in Biological Research* (3rded.). San Francisco, California: Freeman and Company.

Online resources

https://courses.nextgenu.org/course/view.php?id=241&gclid=EAIaIQobChMIzb3Pg7TMgAMVH4NLBR0Cvg2LEAAYASAAEgLHwvD_BwE

https://onlinecourses.swayam2.ac.in/ugc19_ma03/preview

K1-Remember	***K2-Understand***	***K3- Apply***	***K4-Analyze***	***K5-Evaluate***	***K6-Create***

Course Designed by: Dr.R.Jeyabalan

Course Outcome VS Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M(2)	S(3)	M(2)	L(1)	S(3)	S(3)	M(2)	M(2)	S(3)	S(3)
CO2	M(2)	M(2)	S(3)	S(3)	M(2)	S(3)	L(1)	S(3)	S(3)	S(3)
CO3	S(3)	S(3)	S(3)	S(3)	S(3)	S(3)	S(3)	M(2)	S(3)	M(2)
CO4	L(1)	M(2)	M(2)	S(3)	S(3)	S(3)	M(2)	S(3)	M(2)	S(3)
CO5	S(3)	S(3)	M(2)	M(2)	L(1)	S(3)	S(3)	S(3)	S(3)	M(2)
AVG	2.2	2.6	2.4	2.4	2.4	3	2.2	2.6	2.8	2.6

S –Strong (3), M-Medium (2), L- Low (1)

Course Outcome VS Programme Specific Outcomes

CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S(3)	M(2)	S(3)	M(2)	S(3)
CO2	S(3)	S(3)	L(1)	S(3)	M(2)
CO3	S(3)	M(2)	M(2)	S(3)	S(3)
CO4	S(3)	S(3)	M(2)	S(3)	M(2)
CO5	S(3)	L(1)	S(3)	M(2)	S(3)
AVG	3	2.2	2.2	2.6	2.6

S –Strong (3), M-Medium (2), L- Low (1)

SCIENCE CAMPUS