DEPARTMENT OF
MATHEMATICS

Curriculum and Syllabus for
Undergraduate Programmes
Under Credit Semester System
(with effect from 2019 admissions)

St Berchmans College
Founded 1922
AUTONOMOUS | College with Potential for Excellence | Reaccredited by NAAC with A Grade
Affiliated to Mahatma Gandhi University, Kottayam, Kerala
Changanassery, Kottayam, Kerala, India-686101

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PREFACE

"*The study of Mathematics, like the Nile, begins in minuteness but ends in magnificence*"

– Charles Caleb Colton

Mathematics education has been a focus of attention around the world over the last few decades. New standards for instructions and curriculum have been developed and as a result the discourses among the international fraternity of Mathematics scholars help to maintain the academic standards of the hour. The need for new scholars and teachers in Mathematics is indispensable.

This syllabus helps the undergraduate students to comprehend the basics of Mathematics, equips them to go for higher studies and to become teachers in Mathematics, creative scholars and future leaders.

We gave at most attention in keeping the balance between pure and applied, classical and recent topics.

I hope this curriculum and restructured syllabus would enrich the understanding of students in various fields of Mathematics.

Dr Antony Mathews
Chairman, Board of Studies

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12. Ms Treesa Maria Kuriakose, Assistant Professor, Department of Mathematics, St Berchmans College, Changanassery
13. Ms Jinu Mary Jameson, Assistant Professor, Department of Mathematics, St Berchmans College Changanassery

PROGRAMME OBJECTIVES

- To bridge the gap between the plus two and post graduate levels of Mathematics by providing a more complete and logic frame work in almost all areas of basic Mathematics.
- To improve retention of mathematical concepts in the student.
- To develop a spirit of inquiry in the student.
- To improve the perspective of students on Mathematics as per modern requirement.
- To initiate students to enjoy Mathematics, pose and solve meaningful problems and to understand the basic structure of Mathematics.
- To help students in the exploration of mathematical concepts through activities and experimentation using the facilities like Matlab, Geogebra, Scilab, etc available in Mathematical Modelling Division.
- To orient students towards relating Mathematics to applications.
- To foster experimental, problem-oriented and discovery learning of Mathematics.
- To provide greater scope for individual participation in the process of learning and becoming autonomous learners.
- To help the student build interest and confidence in learning the subject.
- By the end of sixth semester, the students should have covered a range of topics in almost all areas of Mathematics and had experience of independent works such as project, seminar etc.

PROGRAMME OUTCOME

- The students acquire basic skills in analysis, algebra, discrete mathematics using interactions, problem solving, discussions, presentations, seminars etc.
- Develop the skills necessary to formulate and understand proofs and to provide justification.
- The students cover a range of topics in almost all areas of Mathematics and had experience of independent works such as project, seminar etc.
- Acquire deep knowledge of different mathematical and computational discipline so that they can qualify various entrance exams.
- Enable the students to pursue higher studies in Mathematics

REGULATIONS FOR UNDERGRADUATE (UG) PROGRAMMES UNDER CREDIT SEMESTER SYSTEM (SB-CSS-UG) 2019

1. SHORT TITLE

1.1 These Regulations shall be called St. Berchmans College (Autonomous) Regulations (2019) governing undergraduate programmes under Credit Semester System.

1.2 These Regulations shall come into force with effect from the academic year 2019 - 20 onwards.

2. SCOPE

2.1 The regulation provided herein shall apply to all regular undergraduate programmes, BA/BSc/BCom/BCA, conducted by St. Berchmans College (Autonomous) with effect from the academic year 2019 - 20.

3. DEFINITIONS

3.1 'University' means Mahatma Gandhi University, Kottayam, Kerala.

3.2 'College' means St. Berchmans College (Autonomous).

3.3 There shall be an Academic Committee nominated by the Principal to look after the matters relating to the SB-CSS-UG system.

3.4 'Academic Council' means the Committee consisting of members as provided under section 107 of the University Act 2014, Government of Kerala.

3.5 'Parent Department' means the Department, which offers a particular undergraduate programme.

3.6 'Department Council' means the body of all teachers of a Department in the College.

3.7 'Faculty Mentor' is a teacher nominated by a Department Council to coordinate the continuous evaluation and other academic activities of the undergraduate programme undertaken in the Department.

3.8 'Programme' means a three year programme of study and examinations spread over six semesters, the successful completion of which would lead to the award of a degree.

3.9 'Duration of Programme' means the period of time required for the conduct of the programme. The duration of an undergraduate programme shall be six (6) semesters.

3.10 'Semester' means a term consisting of a minimum 90 working days, inclusive of tutorials, examination days and other academic activities within a period of six months.

3.11 'Course' means a portion of a subject to be taught and evaluated in a semester.

3.12 'Course Teacher' means the teacher who is taking classes on the course.

3.13 'Core Course' means a course in the subject of specialization within a degree programme. It includes a course on environmental studies and human rights.

3.14 'Complementary Course' means a course, which would enrich the study of core courses.

3.15 'Common Course I' means a course that comes under the category of courses for English.

3.16 'Common Course II' means additional language, which can be opted by a student, from among the languages offered by the College.

3.17 The Common Course I and II is compulsory for all students undergoing undergraduate programmes.

3.18 'Open Course' means a course offered by the departments other than the parent department outside the field specialization of the student, which can be opted by a student.

3.19 'Elective Course' means a course, which can be substituted, by equivalent course from the same subject.

3.20 'Vocational Course' means a course that enables the students to enhance their practical skills and ability to pursue a vocation in their subject of specialization.

3.21 'Audit Course' means a course opted by the students, in addition to the compulsory courses, in order to develop their skills and social responsibility.

3.22 'Extra Credit Course' means a course opted by the students, in addition to the compulsory courses, in order to gain additional credit that would boost the performance level and additional skills.

3.23 Extra credit and audit courses shall be completed by working outside the regular teaching hours.

3.24 There will be two categories of extra credit courses, mandatory and optional. If a student fails to complete the mandatory course, he/she shall complete the same within the tenure of the programme.

The details of the extra credit and audit courses are given below:

Semester	Course	Type
I	Course on Basic Life Support System and Disaster Management	Compulsory, audit course, Grades shall be given
I to VI	Value Education	Compulsory, extra credit
	Virtual Lab experiments/MOOC	Optional, extra credit
II & III	Add on Course	Compulsory, extra credit, Grades shall be given
Summer vacation following semester II	50 hours (10 days) Social Awareness Programme	Compulsory, extra credit, Grades shall be given
IV	Internship/Skill Training	Compulsory, audit course, Grades shall be given
V	Finishing School	Compulsory, audit course

3.25 'On the Job Training' means a job training course given to the students to acquaint them with various industrial skills.

3.26 'Project' means a regular project work with stated credits on which the student conducts a project under the supervision of a teacher in the parent department/any appropriate research centre in order to submit a dissertation on the project work as specified.

3.27 'Dissertation' means a minor thesis to be submitted at the end of a research work carried out by each student on a specific area.

3.28 'Plagiarism' is the unreferenced use of other authors' material in dissertations and is a serious academic offence.

3.29 'Seminar' means a lecture expected to train the student in self-study, collection of relevant matter from books and internet resources, editing, document writing, typing and presentation.

3.30 'Improvement Examination' is an examination conducted to improve the performance of a student in the courses of a particular semester as per the exam manual.

3.31 'Supplementary Examination' is an examination conducted for students who fail in the courses of a particular semester as per the exam manual.

3.32 The minimum credits, required for completing an undergraduate programme is one hundred and twenty (120).

3.33 'Credit' (C) of a course is a measure of the weekly unit of work assigned for that course in a semester.

3.34 'Course Credit': One credit of the course is defined as a minimum of one (1) hour lecture/minimum of two (2) hours lab/field work per week for eighteen (18) weeks in a semester. The course will be considered as completed only by conducting the final examination.

3.35 'Grade' means a letter symbol (A, B, C etc.) which indicates the broad level of performance of a student in a course/semester/programme.

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

3.37 'Credit Point' (CP) of a course is the value obtained by multiplying the grade point (GP) by the credit (C) of the course.

3.38 'Semester Grade Point Average' (SGPA) of a semester is calculated by dividing total credit points obtained by the student in a semester by total credits of that semester and shall be rounded off to two decimal places.

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

3.40 'Institution Average' is the value obtained by dividing the sum of the marks obtained by all students in a particular course by the number of students in the respective course.

3.41 'Weighted Average Score' means the score obtained by dividing sum of the products of marks secured and credit of each course by the total credits of that semester/programme and shall be rounded off to two decimal places.

3.42 'Grace Marks' means marks awarded to course/courses as per the choice of the student, in recognition of meritorious achievements of a student in NCC/NSS/sports/arts and cultural activities.

3.43 First, Second, Third, Fourth and Fifth position shall be awarded to students who come in the first five places based on the overall CGPA secured in the programme in the first chance itself.

4. PROGRAMME STRUCTURE

4.1. The programme shall include core courses, vocational courses, complementary courses, common courses, open course and elective courses. There shall be a project/dissertation to be undertaken by all students. The programme will also include assignments, seminars, practical, viva-voce, OJT, field visit, industry visit etc., if they are specified in the curriculum.

4.2. Total credits for a programme is one hundred and twenty (120). The credit distribution for various UG programmes is shown below.

Model I BA/BSc

i.	Programme duration	6 Semesters
ii.	Total credits required for successful completion of the programme	120
iii.	Minimum credits required from Core + Elective + Project + Complementary courses	79
iv.	Minimum credits required from Common courses	38
v.	Minimum credits required from Open course	3
vi.	Minimum attendance required	75%

4.3. **Project/Dissertation**

All students shall do a project/research work in the area of core course in the sixth semester. The project/ research work shall be done individually or as a group of maximum five (5) students. The projects/research work shall be identified during the fourth semester of the

programme with the help of the supervising teacher. The report of the project/research work shall be submitted to the department during sixth semester and shall be produced before the examiners appointed by the College. The project report/dissertation shall be subject to internal and external evaluation followed by a viva-voce/defence.

4.4. **Evaluations**

The evaluation of each course shall contain two parts.

i Internal or In-Semester Assessment (ISA)

ii External or End-Semester Assessment (ESA)

Both ISA and ESA shall be carried out using indirect grading. The ISA:ESA ratio shall be 1:4, for courses with or without practical. There shall be a maximum of eighty (80) marks for external evaluation and twenty (20) marks for internal evaluation.

4.5. **In-semester assessment**

The components of the internal or in-semester assessment and their marks are as below.

Courses other than common courses without practical

Component	Marks
Attendance	2
Viva	4
Assignment/Seminar	4
Class test	4
Model examination	6
Total	**20**

Marks for attendance

% of Attendance	Marks
Above 90	2
75 – 90	1

(Decimals shall be rounded off to the next higher whole number)

Component	Marks
Attendance	2
Lab Test	4
Record*	4
Total	**10**

*Marks awarded for Record shall be related to number of experiments/practicals recorded.

4.6. **Assignments**

Assignments shall be submitted for every course in the first four semesters. At least one assignment for each course shall be submitted in each semester.

4.7. **Seminar**

A student shall present a seminar in the fifth and sixth semesters.

4.8. **In-semester examination**

Every student shall undergo at least two in-semester examinations as class test and model examination as internal component for every course.

4.9. To ensure transparency of the evaluation process, the ISA mark awarded to the students in each course in a semester shall be published on the notice board according to the schedule in the academic calendar published by the College. There shall not be any chance for improvement of ISA. The course teacher and the faculty mentor shall maintain the academic record of each

student registered for the course which shall be forwarded to the office of the Controller of Examinations through the Head of the Department and a copy shall be kept in the office of the Head of the Department for at least two years for verification.

4.10. A student who has not secured minimum marks in internal examinations can redo the same before the end semester examination of the semester concerned.

4.11. **End-semester assessment**

The end-semester examination in theory and practical courses shall be conducted by the College.

4.12. The end-semester examinations shall be conducted at the end of each semester. There shall be one end-semester examination of three (3) hours duration in each lecture based course.

4.13. The question paper shall be strictly on the basis of model question paper set by Board of Studies.

4.14. A question paper may contain short answer type/annotation, short essay type questions/problems and long essay type questions. Marks for each type of question can vary from programme to programme, but a general pattern may be followed by the Board of Studies.

4.15. End-semester Examination question pattern shall be as given below.

Courses without practical

Section	Total No. of Questions	Questions to be Answered	Marks	Total Marks for the Section
A	12	10	2	20
B	9	6	5	30
C	4	2	15	30
			Maximum	**80**

End-semester Examination question pattern of core courses in mathematics for undergraduate programme in Mathematics shall be as given below.

Section	Total Number of Questions	No. of Questions to be Answered	Mark for Each Question	Maximum Marks
A	12	10	1	10
B	At most 13	Questions with total marks 40 will be given. All questions can be answered.	3, 4, 5 or 6	30
C	Four question sets, one from each module. Each set consists of two questions out of which one is to be answered.	4	10	40
			Grand Total	**80**

4.16. Photocopies of the answer scripts of the external examination shall be made available to the students for scrutiny as per the regulations in the examination manual.

4.17. Practical examination shall be conducted annually or in each semester. The duration and frequency of practical examination shall be decided by the respective Board of Studies.

4.18. Practical examination shall be conducted by one external examiner and one internal examiner.

4.19. The marks for end-semester theory and practical examinations are given below

Course	Marks
Courses without practical	80
Course with practical	60
Practical (assessment in each semester)	20
Practical (odd and even semester combined)	40

4.20. The project report/dissertation shall be subject to internal and external evaluation followed by a viva-voce at the end of the programme. Internal Evaluation is to be done by the supervising teacher and external evaluation by an external evaluation board consisting of an examiner appointed by the Controller of Examinations and the Head of the Department or his nominee. A viva-voce/defence related to the project work shall be conducted by the external evaluation board and students have to attend the viva-voce/defence individually.

Components of Project Evaluation	Marks
Internal Evaluation	20
Dissertation (External)	50
Viva-Voce (External)	30
Total	**100**

4.21. If the student fails in project evaluation, he or she shall submit the project report/dissertation after modifying it on the basis of the recommendations of the examiners.

4.22. For all courses (theory and practical) an indirect grading system based on a seven (7) point scale according to the percentage of marks (ISA + ESA) is used to evaluate the performance of the student in that course. The percentage shall be rounded mathematically to the nearest whole number.

Percentage of Marks	Grade	Performance	Grade Point
95 and above	S	Outstanding	10
85 to below 95	A+	Excellent	9
75 to below 85	A	Very Good	8
65 to below 75	B+	Good	7
55 to below 65	B	Above Average	6
45 to below 55	C	Satisfactory	5
35 to below 45	D	Pass	4
Below 35	F	Failure	0

5. CREDIT POINT AND GRADE POINT AVERAGE

5.1. **Credit Point**

Credit Point (CP) of a course is calculated using the formula

CP = C × GP

where C is the credit and GP is the grade point

5.2. **Semester Grade Point Average**

Semester Grade Point Average (SGPA) is calculated using the formula

SGPA = TCP/TCS

where TCP is the total credit point of all the courses in the semester and TCS is the total credits in the semester

GPA shall be rounded off to two decimal places.

5.3. **Cumulative Grade Point Average**

Cumulative Grade Point Average (CGPA) is calculated using the formula

CGPA = TCP/TC

where TCP is the total credit point of all the courses in the whole programme and TC is the total credit in the whole programme

GPA shall be rounded off to two decimal places.

5.4. **Grade Point Average (GPA)** of different category of courses viz. Common Course I, Common Course II, Complementary Course I, Complementary Course II, Vocational Course, Core Course etc. are calculated using the formula

GPA = TCP/TC

where TCP is the Total Credit Point of a category of course and TC is the total credit of that category of course

Grades for the different courses, semesters, Semester Grade Point Average (SGPA) and grades for overall programme, Cumulative Grade Point Average (CGPA) are given based on the corresponding Grade Point Average (GPA) as shown below:

GPA	Grade	Performance
9.5 and above	S	Outstanding
8.5 to below 9.5	A+	Excellent
7.5 to below 8.5	A	Very Good
6.5 to below 7.5	B+	Good
5.5 to below 6.5	B	Above Average
4.5 to below 5.5	C	Satisfactory
3.5 to below 4.5	D	Pass
Below 3.5	F	Failure

5.5. A separate minimum of 30% marks each for internal and external (for both theory and practical) and aggregate minimum of 35% are required for a pass in a course.

5.6. For a pass in a programme, a separate minimum of grade 'D' is required for all the individual courses.

5.7. If a candidate secures F Grade for any one of the courses offered in a semester/programme, only F grade will be awarded for that semester/programme until the student improves this to D grade or above within the permitted period.

5.8. Candidate who secures D grade and above will be eligible for higher studies.

6. SUPPLEMENTARY/IMPROVEMENT EXAMINATION

6.1 There will be supplementary examinations and chance for improvement. Only one chance will be given for improving the marks of a course.

6.2 There shall not be any improvement examination for practical examinations and examinations of the final year.

7. ATTENDANCE

7.1. The minimum requirement of aggregate attendance during a semester for appearing the end semester examination shall be 75%. Condonation of shortage of attendance to a maximum of ten (10) days in a semester subject to a maximum of two times during the whole period of undergraduate programme may be granted by the College. This condonation shall not be counted for internal assessment.

7.2. Benefit of attendance may be granted to students representing the College, University, State or Nation in Sports, NCC, NSS or Cultural or any other officially sponsored activities such as College union/University union activities etc., on production of participation/attendance certificates, within one week from competent authorities, for the actual number of days

participated, subject to a maximum of ten (10) days in a semester, on the specific recommendations of the Faculty Mentor and Head of the Department.

7.3. A student who does not satisfy the requirements of attendance shall not be permitted to appear for the end-semester examinations.

7.4. Those students who are not eligible even with condonation of shortage of attendance shall repeat the course along with the next batch after obtaining readmission.

8. BOARD OF STUDIES AND COURSES

8.1. The Board of Studies concerned shall design all the courses offered in the UG programme. The Board shall design and introduce new courses, modify or re-design existing courses and replace any existing courses with new/modified courses to facilitate better exposure and training for the students.

8.2. The syllabus of a programme shall contain programme objectives and programme outcome.

8.3. The syllabus of a course shall contain the title of the course, course objectives, course outcome, contact hours, the number of credits, reference materials and model questions.

8.4. Each course shall have an alpha numeric code which includes abbreviation of the course in two letters, the semester number, course code and the serial number of the course.

8.5. Every programme conducted under Credit Semester System shall be monitored by the Academic Council.

9. REGISTRATION

9.1. A student who registers his/her name for the external examination for a semester will be eligible for promotion to the next semester.

9.2. A student who has completed the entire curriculum requirement, but could not register for the semester examination can register notionally, for getting eligibility for promotion to the next semester.

9.3. A student may be permitted to complete the programme, on valid reasons, within a period of twelve (12) continuous semesters from the date of commencement of the first semester of the programme.

9.4. The minimum strength of students for open courses is 15 and the maximum is 75 per batch.

9.5. Each student shall register for the open courses in the prescribed registration form in consultation with the faculty mentor during fourth semester. Faculty mentor shall permit registration on the basis of the preferences of the student and availability of seats.

10. ADMISSION

10.1. The admission to all UG programmes shall be as per the rules and regulations of the College/University.

10.2. The eligibility criteria for admission shall be as announced by the College/University from time to time.

10.3. Separate rank lists shall be drawn up for seats under reservation quota as per the existing rules.

10.4. There shall be an academic and examination calendar prepared by the College for the conduct of the programmes.

11. MARK CUM GRADE CARD

11.1. The College under its seal shall issue to the students, a Mark cum Grade Card on completion of each semester, which shall contain the following information.

i. Name of the Student
ii. Register Number
iii. Photo of the student

iv. Degree
v. Programme
vi. Semester and Name of the Examination
vii. Month and Year of Examination
viii. Stream
ix. Course Code, Title and Credits of each course opted in the semester
x. Marks for ISA, ESA, Total Marks (ISA + ESA), Maximum Marks, Letter Grade, Grade Point (GP), Credit Point (CP) and Institution Average in each course opted in the semester
xi. Total Credits, Marks Awarded, Credit Point, SGPA and Letter Grade in the semester
xii. Weighted Average Score
xiii. Result
xiv. Credits/Grade of Extra Credit and Audit Courses

11.2. The final Mark cum Grade Card issued at the end of the final semester shall contain the details of all courses taken during the entire programme including those taken over and above the prescribed minimum credits for obtaining the degree. The final Mark Cum Grade Card shall show the CGPA and the overall letter grade of a student for the entire programme.

11.3. A separate grade card shall be issued at the end of the final semester showing the extra credit and audit courses attended by the student, grade and credits acquired.

12. AWARD OF DEGREE

The successful completion of all courses other than extra credit and audit courses with 'D' grade shall be the minimum requirement for the award of the degree.

13. MONITORING COMMITTEE

There shall be a Monitoring Committee constituted by the Principal to monitor the internal evaluation conducted by the College. The Course Teacher, Faculty Mentor, and the College Coordinator shall keep all the records of the continuous evaluation, for at least a period of two years, for verification.

14. GRIEVANCE REDRESS MECHANISM

14.1. In order to address the grievance of students regarding ISA, a two-level grievance redress mechanism is envisaged.

14.2. A student can approach the upper level only if grievance is not addressed at the lower level.

14.3. Department level: The Principal shall form a Grievance Redress Committee in each Department comprising of course teacher and one senior teacher as members and the Head of the Department as Chairman. The Committee shall address all grievances relating to the internal assessment of the students.

14.4. College level: There shall be a College level Grievance Redress Committee comprising of Faculty Mentor, two senior teachers and two staff council members (one shall be an elected member) and the Principal as Chairman. The Committee shall address all grievances relating to the internal assessment of the students.

15. TRANSITORY PROVISION

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

REGULATIONS FOR ADD ON COURSES FOR UNDERGRADUATE PROGRAMMES

1. DEFINITIONS

1.1 'Add On Course General Coordinator' is a senior teacher nominated by the Principal to coordinate and monitor the Add On courses conducted by various departments.

1.2 'Add On Course Coordinator' is a teacher nominated by a Department Council to coordinate the evaluation and other academic activities of the Add On Course undertaken in the Department.

2. COURSE STRUCTURE

2.1 Add On Course shall be completed outside the regular teaching hours of the undergraduate programmes and shall be completed within the first four semesters of the programme.

2.2 The credit will be awarded only if the student get D grade (35% marks) and above.

2.3 A student can earn any number of extra credits according to his/her choice.

2.4 The minimum credits for an Add On Course shall be two (2).

3. EVALUATIONS

The evaluation of each course shall be done internally and contain two parts.

i. Continuous evaluation
ii. Final evaluation

Both continuous evaluation and final evaluation shall be carried out using indirect grading. The marks for continuous evaluation is twenty (20) and that of final evaluation is eighty (80).

Continuous evaluation

The components of the continuous evaluation and their marks are as below.

For all courses without practical

There are two components for continuous evaluation, which include attendance and assignment. All the components of the continuous evaluation are mandatory.

Components	Marks
Attendance	10
Assignment	10
Total	**20**

Marks for attendance

% of Attendance	Marks
90 and above	10
85 - 89	8
80 – 84	6
76 – 79	4
75	2

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

For all courses with practical

The components for continuous evaluation of courses with practical are given below.

Components	Marks
Attendance	10
Lab involvement	10
Total	**20**

Marks for attendance

% of Attendance	Marks
90 and above	10
85 - 89	8
80 – 84	6
76 – 79	4
75	2

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

Assignments

At least one assignment shall be submitted for each course.

4. **FINAL EVALUATION**

The final evaluation of theory and practical courses shall be conducted by the College/Department. It can be eighty marks written examination or eighty marks project/practical examination or eighty marks written and project/practical examination combined, as decided by the Board of Studies.

4.1 The question paper shall be strictly on the basis of model question paper set by Board of Studies.

4.2 A question paper may contain objective type, short answer type/annotation, short essay type questions/problems and long essay type questions.

4.3 The duration of written examination shall be decided by the respective Board of Studies and the duration of the practical examination shall be decided by the concerned course coordinator.

4.4 Practical examination shall be conducted by one internal examiner.

4.5 For all courses (theory and practical) an indirect grading system based on a seven (7) point scale according to the percentage of marks (ISA + ESA) is used to evaluate the performance of the student in that course. The percentage shall be rounded mathematically to the nearest whole number.

Percentage of Marks	Grade	Performance
95 and above	S	Outstanding
85 to below 95	A+	Excellent
75 to below 85	A	Very Good
65 to below 75	B+	Good
55 to below 65	B	Above Average
45 to below 55	C	Satisfactory
35 to below 45	D	Pass
Below 35	F	Failure

4.6 A separate minimum of 30% marks each for internal and external (for both theory and practical) and aggregate minimum of 35% are required for a pass in a course.

5. **ATTENDANCE**

The minimum requirement of aggregate attendance for appearing the final evaluation shall be 75%.

6. **BOARD OF STUDIES AND COURSES**

6.1 The Board of Studies concerned shall design the Add On Course offered by the department. The Board shall design and introduce new Add On Course, modify or redesign existing Add On

Course and replace any existing Add On course with new/modified Add On course to facilitate better exposure and training for the students.

6.2 The syllabus of an Add On course shall also include the title of the course, contact hours, the number of credits, reference materials and question paper pattern.

6.3 Each course shall have an alpha numeric code which includes programme code, abbreviation of the course in two letters, course code and serial number of the course

6.4 The Add On courses conducted under Credit Semester System shall be monitored by the Academic Council.

6.5 For redressing the complaints in connection with the conduct of Add On course, students shall approach the Grievance Redress Committee functioning in the college.

REGULATIONS FOR CERTIFICATE COURSE IN VALUE EDUCATION FOR UNDERGRADUATE PROGRAMMES

Value Education is a compulsory extra credit course for all the students admitted to the undergraduate programmes.

i. **Duration**

The duration of the course shall be three academic years (six semesters) spanning 60 hrs. There shall be minimum 20 hours in an academic year.

ii. **Evaluation**

The evaluation of each course shall contain two parts.

i. Continuous evaluation
ii. Final evaluation

There shall be a maximum of forty (40) marks for external assessment and ten (10) marks for internal assessment.

Continuous Evaluation

Assignment

The students are supposed to submit at least one assignment in every year and five (5) marks will be given for a submitted assignment

Attendance

The minimum requirement of aggregate attendance during a semester for appearing the end final examination shall be 75%.

Marks for attendance

Maximum of five (5) marks will be given for attendance as follows.

% of Attendance	Marks
90 and above	5
85-89	4
80-84	3
76-79	2
75	1

(Decimals shall be rounded off to the next higher whole number)

Final evaluation

The final examination shall be conducted by the course coordinator. The final assessment examination shall be conducted at the end of every year. There shall be an annual written examination of one and a half hours (1½) duration. The question paper shall be strictly on the basis of model question paper set by Expert Committee. A question paper consists of short answer type, short essay type and long essay type questions.

A separate minimum of 30% marks each for internal and external assessment (continuous and final evaluation) and aggregate minimum of 35% are required for a pass in a course.

iii. **Grading**

The total marks of the course shall be one hundred and fifty (150). The grading of the course is as follows:

Percentage of Marks	Grade	Performance
95 and above	S	Outstanding
85 to below 95	A+	Excellent
75 to below 85	A	Very Good
65 to below 75	B+	Good
55 to below 65	B	Above Average
45 to below 55	C	Satisfactory
35 to below 45	D	Pass
Below 35	F	Failure

iv. **Award of certificate**

The course is envisaged with three levels in three academic years. There shall be examination in every year. If a student does not acquire minimum marks he/she can continue with further levels. But he/ she shall be eligible to get certificate only after completing all the levels successfully. The certificate will be issued after completing all the levels with minimum grade D for the pass. On successful completion of the course, grade card shall be issued to the students indicating the grade. The college issues the certificate on value education to all the undergraduate students who successfully complete the course. The course shall be completed during the tenure of the programme.

REGULATIONS FOR COURSE ON BASIC LIFE SUPPORT SYSTEM AND DISASTER MANAGEMENT (BLS & DM)

i. The course on BLS & DM shall be conducted by a nodal centre created in the college.

ii. The nodal centre shall include at least one teacher from each department. A teacher shall be nominated as the Director of BLS & DM.

iii. The team of teachers under BLS & DM shall function as the trainers for BLS & DM.

iv. The team of teachers under BLS & DM shall be given intensive training on Basic Life Support System and Disaster Management and the team shall be equipped with adequate numbers of mannequins and kits for imparting the training to students.

v. Each student shall under go five (5) hours of hands on training in BLS & DM organised by the Centre for BLS & DM.

vi. The training sessions shall be organised on weekends/holidays/vacation during the first semester of the programme.

vii. After the completion of the training, the skills acquired shall be evaluated using an online test and grades shall be awarded.

viii. Nodal centre for BLS & DM shall conduct online test and publish the results.

ix. The grading of the course is as follows:

Percentage of Marks	Grade	Performance
95 and above	S	Outstanding
85 to below 95	A+	Excellent
75 to below 85	A	Very Good
65 to below 75	B+	Good
55 to below 65	B	Above Average
45 to below 55	C	Satisfactory
35 to below 45	D	Pass
Below 35	F	Failure

x. Students who could not complete the requirements of the BLS & DM training shall appear for the same along with the next batch. There shall be two redo opportunity.

xi. For redressing the complaints in connection with the conduct of BLS & DM students shall approach the Grievance Redress Committee functioning in the college.

REGULATIONS FOR SOCIAL AWARENESS PROGRAMME (SAP)

i. Social Awareness Programme shall be conducted by a nodal centre created in the college.

ii. The nodal centre shall include at least one teacher from each department. A teacher shall be nominated as the Director of the SAP.

iii. The centre shall identify the areas where the students can serve the society through the SAP.

iv. During the first semester itself, the centre for SAP shall organise programmes to sensitize the students about the significance and relevance of SAP and publish a list of different areas where they can work as volunteers. Students shall register their preferences (three) with the centre for SAP. The centre shall allot students to various areas based on their preference. For the preparation of the allotment list, the marks obtained in the higher secondary examination shall also be used as a criterion. Centre for SAP shall take the help of the Head of the concerned department and the mentor(s) of the concerned batch at the time of finalization of the allotment list.

v. Students shall carry out the voluntary work allotted to them after the regular class hours/weekends/holidays falling in the second semester or the summer vacation following the second semester.

vi. Evaluation of the SAP activity shall be based on the hours of work put in by a student. A minimum of 50 hours of social work (corresponding to 50 marks) is required for the successful completion of SAP. Every additional work beyond the minimum 50 hours shall fetch five (5) marks per hour. Maximum marks shall be 100. Students who donate blood during the second semester shall be given 10 marks upon the production of the certificate from the medical officer. However, Marks earned through blood donation shall not be counted for a pass in the programme. Mark for blood donation shall be awarded only once during the SAP.

vii. Upon completion of SAP, the marks earned and the grades awarded shall be published by the Director of SAP. The grading is as follows:

Percentage of Marks	Grade	Performance
95 and above	S	Outstanding
85 to below 95	A+	Excellent
75 to below 85	A	Very Good
65 to below 75	B+	Good
55 to below 65	B	Above Average
45 to below 55	C	Satisfactory
35 to below 45	D	Pass
Below 35	F	Failure

viii. Two credits shall be awarded to students who complete the requirements of SAP.

ix. Students who could not complete the requirements of the SAP shall appear for the same with the next batch. There shall be two redo opportunity.

x. For redressing the complaints regarding allotment, harassment at the place of work, and the marks and grades awarded students shall approach the Grievance Redress Committee functioning in the college.

xi. Director of SAP has the right to exclude students who are physically handicapped from SAP.

REGULATIONS FOR INTERNSHIP/SKILL TRAINING PROGRAMME

i. Every UG student shall undergo an internship for a minimum period of five days (25 hours) at a centre identified by the concerned department. In the case of disciplines where internship opportunities are scanty (eg. Mathematics) special skill training programmes with duration of five days (25 hours) shall be organised.

ii. Each department shall identify a teacher in charge for internship/skill training programme.

iii. The department shall select institutions for internship/organising skill training programme.

iv. Internship/skill training programme shall be carried out preferably during the summer vacation following the fourth semester or during the Christmas vacation falling in the fourth semester or holidays falling in the semester.

v. At the end of the stipulated period of internship each student shall produce an internship completion cum attendance certificate and an illustrated report of the training he/she has underwent, duly certified by the tutor and Head of the institution where the internship has been undertaken.

vi. Students undergoing skill training programme shall submit a training completion cum attendance certificate and a report of the training he/she has underwent, duly certified by the trainer, teacher co-ordinator of the programme from the concerned department and the head of the department concerned.

vii. Upon receipt of the internship completion cum attendance certificate and illustrated report of the training or a training completion cum attendance certificate and a report of the training, the teacher in charge of internship/skill training programme shall prepare a list of students who have completed the internship/skill training programme and a list of students who failed to complete the programme. Head of the department shall verify the lists and forward the lists to the Controller of Examinations.

viii. Students who could not complete the requirements of the internship/skill training programme shall appear for the same with the next batch. There shall be only one redo opportunity.

REGULATIONS FOR FINISHING SCHOOL

i. The training to help students develop their soft skills and interview skills, 'The Finishing School', shall be coordinated by a nodal centre.

ii. The nodal centre shall include at least one teacher from each department. A teacher shall be nominated as the Director of the nodal centre.

iii. The training shall impart soft skills comprising of language skills, personal presentation and grooming, resume preparation, group discussion techniques, and interview skills among the undergraduate students.

iv. This course shall be conducted during the fifth semester for all the undergraduate students.

v. There will be a total of 20 contact hours which shall be handled by a team of professional members/faculty. In addition, a one-day outbound training session by a team of professional trainers that touches on the aspects of creativity, problem solving and team building shall also be organized.

vi. The students shall be assessed and grades shall be awarded based on the components as shown below.

Component	Marks
Attendance	5
Class Test	10
Assignments	10
Group discussion	10
Interview	15
Total	**50**

vii. The grading of the course is as follows:

Percentage of Marks	Grade	Performance
95 and above	S	Outstanding
85 to below 95	A+	Excellent
75 to below 85	A	Very Good
65 to below 75	B+	Good
55 to below 65	B	Above Average
45 to below 55	C	Satisfactory
35 to below 45	D	Pass
Below 35	F	Failure

viii. For redressing the complaints in connection with the conduct of finishing school students shall approach the Grievance Redress Committee.

VIRTUAL LAB EXPERIMENTS/MOOC

i. There shall be a Nodal officer and a team of teachers to coordinate the logistics for conducting Virtual Lab experiments and MOOC courses and to authenticate the claims of the students regarding the successful completion of the Virtual Lab experiments and or MOOC courses.

ii. Students who are desirous to do Virtual Lab experiments and or MOOC courses shall register with the Nodal officer at the beginning of the experiment session/MOOC course. Students also shall submit proof of successful completion of the same to the Nodal officer.

iii. Upon receipt of valid proof, the nodal officer shall recommend, to the Controller of Examinations, the award of extra credits. In the case of Virtual Lab experiments, 36 hours of virtual experimentation shall equal one credit and in the case of MOOC courses 18 hours of course work shall equal one credit.

iv. College shall arrange infrastructure for taking up Virtual Lab experiments and/or MOOC courses.

St Berchmans College
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Affiliated to Mahatma Gandhi University, Kottayam, Kerala
Changanassery, Kottayam, Kerala, India-686101

MARK CUM GRADE CARD

Date:

Name of the Candidate :

Permanent Register Number (PRN) :

Degree :

Programme :

Stream :

Name of Examination :

Photo

Course Code	Course Title	Credits (C)	Marks						Grade Awarded (G)	Grade Point (GP)	Credit Point (CP)	Institution Average	Result
			ISA		ESA		Total						
			Awarded	Maximum	Awarded	Maximum	Awarded	Maximum					
	Common Course I												
	Common Course II												
	Core Course												
	Complementary Course												
	Total												
	Weighted Average Score												
	Semester Result												
	SGPA												
	End of Statement												

Entered by:

Verified by:

Controller of Examinations **Principal**

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E-mail: sbc@sbcollege.org Web: www.sbcollege.ac.in

CONSOLIDATED MARK CUM GRADE CARD

Photo

Name of the Candidate :

Permanent Register Number (PRN) :

Degree :

Programme :

Stream :

Date :

Course Code	Course Title	Credits (C)	Marks						Grade Awarded (G)	Grade Point (GP)	Credit Point (CP)	Institution Average	Result
			ISA		ESA		Total						
			Awarded	Maximum	Awarded	Maximum	Awarded	Maximum					
SEMESTER I													
	Common Course I **Common Course II** **Core Course** **Complementary Course**												

SEMESTER II													
	Common Course I **Common Course II** **Core Course** **Complementary Course**												
SEMESTER III													
	Common Course I **Common Course II** **Core Course** **Complementary Course**												
SEMESTER IV													
	Common Course I **Common Course II** **Core Course** **Complementary Course**												
SEMESTER V													
	Core Course **Open Course**												
SEMESTER VI													
	Core Course **Project**												

SEMESTER RESULTS

Semester	Marks Awarded	Maximum Marks	Credits	SGPA	Grade	Month & Year of Passing	Result
I II III IV V VI							

PROGRAMME PART RESULTS

Programme Part	Marks Awarded	Maximum Marks	Credits	CGPA	Grade
Common Course I: Common Course II: Core Course: Complementary Course: Complementary Course: Open Course:					
Total					

FINAL RESULT

CUMULATIVE GRADE POINT AVERAGE (CGPA) =

GRADE =

*** Separate grade card is issued for Audit and Extra Credit courses.**
**** Grace Mark awarded.**

Entered by:

Verified by:

Controller of Examinations **Principal**

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

Description of the Evaluation Process

Grade and Grade Point

The evaluation of each course comprises of internal and external components in the ratio 1:4 for all Courses. Grades and Grade Points are given on a seven (7) point scale based on the percentage of Total Marks (ISA + ESA) as given in Table 1. Decimals are corrected to the nearest whole number.

Credit Point and Grade Point Average

Credit Point (CP) of a course is calculated using the formula

CP = C × GP

where C is the Credit and GP is the Grade Point

Grade Point Average of a Semester (SGPA) or Cumulative Grade Point Average (CGPA) for a Programme is calculated using the formula

SGPA or CGPA = TCP/TC

where TCP is the Total Credit Point for the semester/programme and TC is the Total Credit for the semester/programme

GPA shall be rounded off to two decimal places.

The percentage of marks is calculated using the formula;

$$\% \text{ Marks} = \left(\frac{\text{total marks obtained}}{\text{maximum marks}}\right) \times 100$$

Percentage of Marks	Grade	Performance	Grade Point
95 and above	S	Outstanding	10
85 to below 95	A+	Excellent	9
75 to below 85	A	Very Good	8
65 to below 75	B+	Good	7
55 to below 65	B	Above Average	6
45 to below 55	C	Satisfactory	5
35 to below 45	D	Pass	4
Below 35	F	Failure	0

Table 1

Grades for the different Semesters and overall Programme are given based on the corresponding GPA, as shown in Table 2.

GPA	Grade	Performance
9.5 and above	S	Outstanding
8.5 to below 9.5	A+	Excellent
7.5 to below 8.5	A	Very Good
6.5 to below 7.5	B+	Good
5.5 to below 6.5	B	Above Average
4.5 to below 5.5	C	Satisfactory
3.5 to below 4.5	D	Pass
Below 3.5	F	Failure

Table 2

Weighted Average Score (WAS) is the score obtained by dividing sum of the products of marks secured and credit of each course by the total credits of that semester/programme and shall be rounded off to two decimal places.

Note: Course title followed by (P) stands for practical course. A separate minimum of 30% marks each for internal and external assessments (for both theory and practical) and an aggregate minimum of 35% marks is required for a pass in each course. For a pass in a programme, a separate minimum of Grade D for all the individual courses and an overall Grade D or above are mandatory. If a candidate secures Grade F for any one of the courses offered in a Semester/Programme, only Grade F will be awarded for that Semester/Programme until the candidate improves this to Grade D or above within the permitted period.

PROGRAMME STRUCTURE

Semester I

Sl. No.	Course	Hours /Week	Credit	Marks
1	Common Course I	5	4	100
2	Common Course I	4	3	100
3	Common Course II	4	4	100
4	Core Course	4	3	100
5	Complementary Course: Statistics	4	3	100
6	Complementary Course: Physics	2	2	75
7	Complementary Course Practical: Physics	2	Evaluation in Semester II	
	Total	**25**	**19**	**575**

Semester II

Sl. No.	Course	Hours/ Week	Credit	Marks
1	Common Course I	5	4	100
2	Common Course I	4	3	100
3	Common Course II	4	4	100
4	Core Course	4	3	100
5	Complementary Course : Statistics	4	3	100
6	Complementary Course : Physics	2	2	75
7	Complementary Course Practical: Physics	2	2	50
	Total	**25**	**21**	**625**

Semester III

Sl. No.	Course	Hours/ Week	Credit	Marks
1	Common Course I	5	4	100
2	Common Course II	5	4	100
3	Core Course	5	4	100
4	Complementary Course : Statistics	5	4	100
5	Complementary Course : Physics	3	3	75
6	Complementary Course Practical: Physics	2	Evaluation in Semester IV	
	Total	**25**	**19**	**475**

Semester IV

Sl. No.	Course	Hours/ Week	Credit	Marks
1	Common Course I	5	4	100
2	Common Course II	5	4	100
3	Core Course	5	4	100
4	Complementary Course : Statistics	5	4	100
5	Complementary Course : Physics	3	3	75
6	Complementary Course Practical: Physics	2	2	50
	Total	**25**	**21**	**525**

Semester V

Sl. No.	Course	Hours/ Week	Credit	Marks
1	Core Course	5	4	100
2	Core Course	6	4	100
3	Core Course	5	4	100
4	Core Course	6	4	100
5	Open Course	3	3	100
	Total	**25**	**19**	**500**

Semester VI

Sl. No.	Course	Hours/ Week	Credit	Marks
1	Core Course	5	4	100
2	Core Course	5	4	100
3	Core Course	5	4	100
4	Core Course	5	4	100
5	Elective Course	5	4	100
6	Project	-	1	100
	Total	**25**	**21**	**600**
	Grand Total	**-**	**120**	**3300**

OUTLINE OF THE CORE COURSES

Course Code	Course Title	Hours /Week	Total Hours	Credit	ISA	ESA	Total
Semester I							
BBMM101	Foundations of Mathematics - I	4	72	3	20	80	100
Semester II							
BBMM202	Foundations of Mathematics - II	4	72	3	20	80	100
Semester III							
BBMM303	Mathematical Analysis – I	5	90	4	20	80	100
Semester IV							
BBMM404	Mathematical Analysis – II	5	90	4	20	80	100
Semester V							
BBMM505	Mathematical Analysis – III	5	90	4	20	80	100
BBMM506	Linear Algebra	6	108	4	20	80	100
BBMM507	Abstract Algebra	5	90	4	20	80	100
BBMM508	Environmental Issues, Human Rights and Differential Equations	6	108	4	20	80	100
Semester VI							
BBMM609	Mathematical Analysis – IV	5	90	4	20	80	100
BBMM610	Complex Analysis	5	90	4	20	80	100
BBMM611	Discrete Mathematics	5	90	4	20	80	100
BBMM612	Metric Spaces	5	90	4	20	80	100
	Elective Course	5	90	4	20	80	100
BBMM6PJ	Project	-	-	1	20	80	100

ELECTIVE COURSES

Course Code	Course Title	Hours /Week	Total Hours	Credit	ISA	ESA	Total
BBMM6E01	Operations Research	5	90	4	20	80	100
BBMM6E02	Programming in C	5	90	4	20	80	100
BBMM6E03	Topology	5	90	4	20	80	100
BBMM6E04	Theory of Computation	5	90	4	20	80	100
BBMM6E05	Numerical Methods	5	90	4	20	80	100

COMPLEMENTARY COURSES IN MATHEMATICS FOR UNDERGRADUATE PROGRAMME IN PHYSICS

Course Code	Course Title	Hours /Week	Total Hours	Credit	ISA	ESA	Total
Semester I							
BDMP101	Mathematics for Physics - I	4	72	3	20	80	100
Semester II							
BDMP202	Mathematics for Physics - II	4	72	3	20	80	100
Semester III							
BDMP303	Mathematics for Physics - III	5	90	4	20	80	100
Semester IV							
BDMP404	Mathematics for Physics - IV	5	90	4	20	80	100

COMPLEMENTARY COURSES IN MATHEMATICS FOR UNDERGRADUATE PROGRAMME IN CHEMISTRY

Course Code	Course Title	Hours /Week	Total Hours	Credit	ISA	ESA	Total
Semester I							
BDMC101	Mathematics for Chemistry - I	4	72	3	20	80	100
Semester II							
BDMC202	Mathematics for Chemistry - II	4	72	3	20	80	100
Semester III							
BDMC303	Mathematics for Chemistry - III	5	90	4	20	80	100
Semester IV							
BDMC404	Mathematics for Chemistry - IV	5	90	4	20	80	100

COMPLEMENTARY COURSES IN MATHEMATICS FOR UNDERGRADUATE PROGRAMME IN COMPUTER APPLICATIONS

Course Code	Course Title	Hours /Week	Total Hours	Credit	ISA	ESA	Total
Semester I							
BDMA101	Discrete Mathematics - I	4	72	3	20	80	100
Semester II							
BDMA202	Discrete Mathematics - II	4	72	3	20	80	100

COMPLEMENTARY COURSES IN STATISTICS FOR UNDERGRADUATE PROGRAMME IN MATHEMATICS

Course Code	Course Title	Hours /Week	Total Hours	Credit	ISA	ESA	Total
Semester I							
BDSM101	Basic Statistics	4	72	3	20	80	100
Semester II							
BDSM202	Theory of Probability and Random Variables	4	72	3	20	80	100
Semester III							
BDSM303	Probability Distributions	5	90	4	20	80	100
Semester IV							
BDSM404	Statistical Inference	5	90	4	20	80	100

COMPLEMENTARY STATISTICS FOR UNDERGRADUATE PROGRAMME IN COMPUTER APPLICATIONS

Course Code	Course Title	Hours /Week	Total Hours	Credit	ISA	ESA	Total
Semester I							
BDSC101	Introductory Statistics	4	72	3	20	80	100
Semester III							
BDSC302	Advanced Statistics	4	72	4	20	80	100
Semester IV							
BDSC403	Optimization Techniques	4	72	4	20	80	100

OPEN COURSES

Course Code	Course Title	Hours /Week	Total Hours	Credit	ISA	ESA	Total
BOMM501	Mathematical Modelling	3	54	3	20	80	100
BOMM502	Applicable Mathematics	3	54	3	20	80	100
BOMM503	Financial Mathematics	3	54	3	20	80	100
BOMM504	Mathematical Economics	3	54	3	20	80	100

ADD ON COURSES

Course Code	Course Title	Total Hours	Credit	CE	FE	Total
BMMEX01	Free and Open Source Software - LaTeX	36	2	10	40	50
BMMEX02	Quantitative Techniques for Competitive Examinations	36	2	20	80	100
BMMEX03	Reasoning Ability	36	2	20	80	100

SEMESTER I

BBMM101: FOUNDATIONS OF MATHEMATICS - I

Total Hours: 72

Credit: 3

COURSE OBJECTIVE

- To gain a better understanding of what happens in the course of a proof and a systematic language or framework within which to develop the ideas involved.
- To understand Propositional calculus more clearly
- To introduce the deceptively simple but crucially important idea of quantification.
- Introduces the terminologies and notations that comprise the language of modern mathematics.
- To acquire basic knowledge of curve and surfaces.

COURSE OUTCOME

- Demonstrate accurate and efficient use of logical and set theoretical techniques.
- Explain the fundamental concepts from the foundations of mathematics and its role in modern mathematics and applied contexts.
- Able to write and understand proofs as formal logical process.
- Refine geometrical problem-solving and analysis skills and relate them to existing body of knowledge in mathematics, physics, and engineering.

TEXT BOOKS

1. D L JOHNSON, ELEMENTS OF LOGIC VIA NUMBERS AND SETS, SPRINGER, 1998.
2. THOMAS AND FINNEY, CALCULUS AND ANALYTIC GEOMETRY, NINTH EDITION, PEARSON, 1995

MODULE 1: NUMBERS AND LOGIC - 20 Hours

Arithmetic Progressions, Proof by Contradiction, Proof by Contraposition, Proof by Induction, Inductive Definition, The Well-ordering Principle, Propositions, Truth Tables, Syllogisms, Quantifiers.

Text Book 1- Sections 1.1-1.6; 2.1-2.4.

MODULE 2: SETS AND RELATIONS - 18 Hours

Introduction to Sets, Operations, Laws, The Power Set, Equivalence Relations, Congruence, Number Systems, Orderings.

Text Book 1 - Sections 3.1-3.4; 4.1-4.4.

MODULE 3: MAPS AND CARDINAL NUMBERS - 18 Hours

Terminology and Notation, Examples, Injections, Surjections, Bijections, Peano's Axioms, Cardinal arithmetic, The Cantor-Schroeder-Bernstein theorem, Countable Sets, Uncountable Sets.

Text Book 1 - Sections 5.1-5.4; 6.1-6.4.

MODULE 4: CURVES AND SURFACES - 16 Hours

Circle, Parabola, Ellipse, Hyperbola, Classifying Conic sections by eccentricity, Quadratic equations and rotations, Parametrization of Plane Curves, Cylinders and Quadric Surfaces, Cylindrical and Spherical coordinates.

Text Book 2 – Sections 9.1-9.8; 10.6-10.7

REFERENCES

1. S.L. LONEY: PLANE TRIGONOMETRY PART – II, S. CHAND AND COMPANY LTD, 1983
2 IAN CHISWELL & WIFRID HODGES: MATHEMATICAL LOGIC, OXFORD UNIVERSITY PRESS, 2007
3 K.H. ROSEN: DISCRETE MATHEMATICS AND ITS APPLICATIONS (SIXTH EDITION), TATA MCGRAW HILL PUBLISHING COMPANY, NEW DELHI, 1999
4 LIPSCHUTZ: SET THEORY AND RELATED TOPICS (SECOND EDITION), SCHAUM OUTLINE SERIES, TATA MCGRAW HILL PUBLISHING COMPANY, NEW DELHI, 2005

SEMESTER II

BBMM202: FOUNDATIONS OF MATHEMATICS - II

Total Hours: 72

Credit: 3

COURSE OBJECTIVE

- Better understanding of matrices and matrix algebra.
- Introducing students to the fundamental concepts of linear algebra culminating in abstract vector spaces and linear transformations.
- To expose the students to the basics of real number system.
- Introduction to number theory with applications

COURSE OUTCOME

- Use Gauss-Jordan elimination to solve systems of linear equations and to compute the inverse of an invertible matrix.
- Use the basic concepts of vector and matrix algebra, including linear dependence / independence, basis and dimension of a subspace, rank and nullity, for analysis of matrices and systems of linear equations.
- Knowledge of the basic definitions and theorems in number theory
- Ability to apply number theory algorithms and procedures to basic problems
- Ability to think and reason about abstract mathematics

TEXT BOOKS

1. R G BARTLE AND D R SHERBERT: INTRODUCTION TO REAL ANALYSIS, THIRD EDITION, WILEY, 2000.
2. DAVID M. BURTON: ELEMENTARY NUMBER THEORY, SIXTH EDITION, TATA MCGRAW-HILL, 2006.
3. J B FRALEIGH AND R A BEAUREGARD: LINEAR ALGEBRA, THIRD EDITION, ADDISON-WESLEY, 1995.

MODULE 1: VECTORS AND MATRICES - 20 Hours

Vectors in Euclidean Spaces, The norm and the dot product, Matrices and their algebra, Solving systems of linear equations, Inverses of square matrices, Homogenous systems, Subspaces, Bases.

Text Book 3 - Sections 1.1 – 1.6

MODULE 2: REAL NUMBER SYSTEM - 18 Hours

The algebraic and order properties of R, Absolute value and the Real line, The Completeness property of R, Applications of supremum property, Intervals.

Text Book 1 - Sections

MODULE 3: NUMBER THEORY - 18 Hours

Early Number Theory, The Division Algorithm, Greatest Common Divisor, Euclidean algorithm, Fundamental Theorem of arithmetic, Sieve of Eratosthenes

Text Book 2 - Sections 2.1-2.4; 3.1- 3.2

MODULE 4: NUMBER THEORY (contd;) - 16 Hours

Carl Friedrich Gauss, Basic Properties of Congruence, Binary and Decimal Representations of Integers, Linear Congruence and Chinese Remainder Theorem, Pierre De Fermat, Fermat's Little Theorem and Pseudo primes, Wilson's theorem, The sum and number of divisors, Euler phi Function, Euler Theorem.

Text Book 2 - Sections 4.1-4.4; 5.1, 5.3; 6.1; 7.1-7.3

REFERENCES

1. C.Y HSIUNG: ELEMENTARY THEORY OF NUMBERS, ALLIED PUBLISHERS, 1995
2. GRAHAM EVEREST & THOMAS WARD: AN INTRODUCTION TO NUMBER THEORY, SPRINGER, 2005
3. FERNANDO RODRIGUEZ VILLEGA: EXPERIMENTAL NUMBER THEORY, OXFORD UNIVERSITY PRESS, 2007
4. S KUMARESAN: LINEAR ALGEBRA - A GEOMETRIC APPROACH, PRENTICE HALL INDIA LEARNING PRIVATE LIMITED; NEW TITLE EDITION (2000)
5. FRANK AYRES JR MATRICES-SCHAUM'S OUTLINE SERIES, TMH EDITION, 1962

SEMESTER III

BBMM303: MATHEMATICAL ANALYSIS - I

Total Hours: 90

Credit: 4

COURSE OBJECTIVES

- Have the rigorous knowledge of limit of functions and its properties.
- Have the knowledge of sequence and series of real numbers and convergence.
- Study the notion of continuous functions and their properties.
- Study the differentiability of real functions and Mean Value theorems.

COURSE OUTCOME

- Recognize convergent, divergent, bounded, and monotone sequences.
- Calculate the limit of a sequence.
- Recognize alternating, convergent, conditionally and absolutely convergent series.
- Apply the ratio, root, comparison and asymptotic comparison tests.
- Determine whether a real function is discontinuous, continuous, or uniformly continuous.
- Realize how to communicating with: Peers, Teachers and Community.
- Acquire ability to apply the theorem in a correct mathematical way.
- Improve logical thinking.

TEXT BOOK

1. CLAUDIO CANUTO, ANITA TABACCO, MATHEMATICAL ANALYSIS I, SPRINGER 2008

MODULE 1: LIMITS AND CONTINUITY I – 20 Hours

Neighborhood, limit of sequences, Euler number, limit of function, continuity, removable discontinuity, types of discontinuity

Sections 3.1-3.3

MODULE 2: LIMITS AND CONTINUITY II – 20 Hours

Uniqueness and sign of the limit, comparison theorems, more fundamental limits, indeterminate forms of exponential type, global features of continuous maps, intermediate value theorem

Sections 4.1-4.3

MODULE 3: NUMERICAL SEQUENCES AND SERIES – 25 Hours

Landau symbols, infinitesimal and infinite functions, further properties of sequences, series, positive term series, alternating series, comparison test, ratio test, root test, Leibniz test, absolute convergence test.

Sections 5.1-5.5

MODULE 4: DIFFERENTIAL CALCULUS - 25 Hours

Derivative, derivatives of elementary functions, Rules of differentiation, algebraic operations, chain rule, derivative of inverse function, non differential points, extrema and critical points, Rolle's theorem, mean value theorem, first and second increment formulas, monotone maps, convexity and inflection points, domain and symmetries, L'Hospital's theorem, Applications of L'Hospital's theorem.

Sections 6.1-6.11

REFERENCES

1. T. M. APOSTOL: CALCULUS VOLUME I & II , WILEY INDIA, 1991
2. DAVID V.WIDDER: ADVANCED CALCULUS, 2ND EDITION, 1989
3. ROBERT G BARTLE AND DONALD R SHERBERT: INTRODUCTION TO REAL ANALYSIS 3RD EDITION, WILEY INDIA, 2011
4. RICHARD R GOLDBERG: METHODS OF REAL ANALYSIS 3RD EDITION, OXFORD AND IBM PUBLISHING CO (1964)

SEMESTER IV

BBMM404: MATHEMATICAL ANALYSIS - II

Total Hours: 90

Credit: 4

COURSE OBJECTIVES

- Have the rigorous knowledge of derivatives of functions and its properties.
- Have the knowledge of critical points, extrema points, increment formula, convexity and inflection points and some theorems related to differentiability in one variable.
- Study the integral calculus and some properties and theorems in one variable..
- Study the improper integral in one variable.

COURSE OUTCOMES

- Recognize critical points, extrema points, increment formula, convexity and inflection points
- Calculate the derivative of a function.
- Recognize power series expansions
- Calculate integrals of functions.
- Determine whether a real function is differentiable, integrable etc.
- Realize how to communicating with: Peers, Teachers and Community.
- Acquire ability to apply the theorem in a correct mathematical way.
- Improve logical thinking.

TEXT BOOK

1. CLAUDIO CANUTO, ANITA TABACCO, MATHEMATICAL ANALYSIS I, SPRINGER 2008

MODULE 1: TAYLOR EXPANSIONS AND APPLICATIONS - 20 Hours

Taylor expansions, Maclaurin's expansion, operations on Taylor expansions, local behavior of a map via its Taylor expansion

Sections 7.1-7.4.

MODULE 2: INTEGRAL CALCULUS – 25 Hours

Primitive functions and indefinite integrals, rules of indefinite integration, integration by parts, integration by substitution, integrating rational maps, definite integrals, Cauchy

integral, Riemann integral, Properties of Definite integrals, integral mean value, mean value theorem, rules of definite integration, computation of areas.
Sections 9.1-9.9

MODULE 3: IMPROPER INTEGRALS – 20 Hours

Unbounded domains of integration, comparison test, absolute convergence test, asymptotic comparison test, integral test, more improper integrals, curves, integrals along curves, length of curve and arc length.
Sections 8.4; 10.1-10.3

MODULE 4: ORDINARY DIFFERENTIAL EQUATIONS - 25 Hours

General Definitions, Equations with separable variables, Linear equations, Homogenous equations, Second order equations reducible to first order, Lipschitz functions, A criterion for solving initial value problems, Linear second order equations with constant coefficients.
Sections 11.1-11.4

REFERENCES

1. T. M. APOSTOL: CALCULUS VOLUME I & II (WILEY INDIA), 1991
2. DAVID V.WIDDER: ADVANCED CALCULUS, 2ND EDITION, 1989
3. G F SIMMONS, S G KRANTZ: DIFFERENTIAL EQUATIONS, TATA MCGRAW HILL, NEW DELHI, 2006
4. HOWARD ANTON, ET AL: CALCULUS, SEVENTH EDITION, JOHN WILEY, 2001

SEMESTER V

BBMM505: MATHEMATICAL ANALYSIS - III

Total Hours: 90

Credit: 4

COURSE OBJECTIVES

- Have the knowledge of sequence and series of functions and convergence.
- Study the notion of uniformly convergent functions and their properties.
- Have the knowledge about Fourier series
- Study functions in Euclidean spaces.
- Study the differentiability of scalar valued functions

COURSE OUTCOMES

- Recognize sequence of functions.
- Calculate the limit of sequence of function.
- Recognize properties of uniform convergence
- Calculate Fourier series.
- Recognize functions in Euclidean spaces, vectors, curves, limits and continuity.
- Calculate and recognise differentiation of scalar functions, Taylor expansions, convexity, extremas, stationary points and saddle points
- Realize how to communicating with: Peers, Teachers and Community.
- Acquire ability to apply the theorem in a correct mathematical way.
- Improve logical thinking.

TEXT BOOK

1. CLAUDIO CANUTO, ANITA TABACCO, MATHEMATICAL ANALYSIS II, SPRINGER, 2010

MODULE 1: SEQUENCE AND SERIES OF FUNCTIONS – 25 Hours

Sequence of functions, Properties uniform convergence of sequences, interchanging limits and integrals, interchanging limits and derivatives, series of functions, power series, Algebraic operations, differentiation and integration, analytic functions

Section 2.1-2.5.

MODULE 2: FOURIER SERIES – 20 Hours

Trigonometric polynomial, period, Fourier coefficients and Fourier series, exponential form, differentiation, convergence of Fourier series, quadratic convergence, point wise convergence, uniform convergence, decay of Fourier coefficients, periodic function with period

Section 3.1 – 3.6

MODULE 3: FUNCTIONS IN EUCLIDEAN SPACES – 20 Hours

Vectors in R^n, Matrices, set in R^n and their properties, functions; definition and first examples, continuity and limits, properties of limits and continuity, curves in R^m, surfaces in R^3.

Section 4.1-4.7

MODULE 4: DIFFERENTIAL CALCULUS FOR SCALAR FUNCTIONS – 25 hours

First partial derivative and gradient, Differentiability and differentials, Mean value theorem and Lipschitz functions, higher order partial derivatives, Taylor expansions, convexity, Extremal points of a function, stationary points, saddle points.

Sections 5.1-5.6.1.

REFERENCES

1. HORST R BAYER : CALCULUS AND ANALYSIS: A COMBINED APPROACH , WILEY, 2010
2. T. M. APOSTOL : CALCULUS VOLUME I & II ,WILEY, 1991

BBMM506: LINEAR ALGEBRA

Total Hours: 108

Credit: 4

COURSE OBJECTIVES

- Introduce the key notions of vector spaces, matrix theory and solving system of linear equations.
- Aims at developing a geometric understanding of finite dimensional vector spaces and linear transformations on them.
- Develop the concepts of eigenvalues, eigen vectors, Diagonalization.
- To have an understanding on inner product spaces, orthogonalization.

COURSE OUTCOMES

- Better understanding of the basic concepts of Vector space, dimension, Linear Transformations and matrices.
- Understanding the geometric ideas and the relationship of vector space theory and matrix theory.
- Able to find the null space, range space of linear transformations.
- Understanding the Gram Schmidt orthogonalization process Ability to pursue further studies in the field

TEXT BOOK

1. J B FRALEIGH AND R A BEAUREGARD, LINEAR ALGEBRA, THIRD EDITION, ADDISON-WESLEY, 1995.

MODULE 1: DIMENSION, RANK AND LINEAR TRANSFORMATION - 26 Hours

Independence and Dimension - The Rank of a Matrix - Linear Transformations of Euclidean Spaces - Linear transformations of the Plane - Lines, Planes and Other Flats

Chapter 2

MODULE 2: VECTOR SPACES - 29 Hours

Vector Spaces - Basic Concepts of Vector Spaces - Coordinatization of Vectors - Linear Transformations

Sections 3.1 - 3.4

MODULE 3: EIGENVALUES, EIGENVECTORS AND CHANGE OF BASIS - 29 Hours

Eigenvalues and Eigenvectors – Diagonalization - Coordinatization and Change of Basis - Matrix Representations and Similarity

Sections 5.1 – 5.2; 7.1 - 7.2

MODULE 4: ORTHOGONALITY - 24 Hours

Inner-Product Spaces – Projections - The Gram-Schmidt Process - Orthogonal Matrices

Sections 3.5; 6.1 - 6.3

REFERENCES

1. SHELDON AXLER: LINEAR ALGEBRA DONE RIGHT SECOND EDITION, SPRINGER,2004
2. J H KWAK, S HONG: LINEAR ALGEBRA, SECOND EDITION, SPRINGER, 2004
3. GILBERT STRANG: LINEAR ALGEBRA AND ITS APPLICATIONS, THIRD EDITION (BOOKWORLD ENTERPRISES), 2005

BBMM507: ABSTRACT ALGEBRA

Total Hours: 90

Credit: 4

COURSE OBJECTIVES

- This course deal adequately with the essentials in Abstract Algebra for an undergraduate student in Mathematics.
- Introduce some new techniques of proof and certain procedures, which will be useful for future courses in pure mathematics.
- Group Theory will help to learn more about the concept of groups, normal subgroups and homomorphism etc.
- Develop the concepts of normal subgroups, group homomorphisms.
- Field Theory will help to learn more about the concept of rings, integral domain and fields etc.

COURSE OUTCOMES

- Numerous exercises discussed during this course will enhance the understanding of the material the students studied.
- Compare class equations and normal series.
- Apply normal subgroups to future papers like Field Theory and Galois Theory.

TEXT BOOK:

1. JOHN B FRALEIGH; A FIRST COURSE IN ABSTRACT ALGEBRA, 7^{TH} EDITION, PEARSON EDUCATION 2007

MODULE 1: GROUP THEORY - 20 Hours

Introduction and examples, Binary operations, Isomorphic binary structures, How to show that binary structures are isomorphic (not isomorphic), Groups, Elementary properties of groups, subgroups, cyclic sub groups.

Chapters 1 – 5

MODULE 2: FURTHER TOPICS IN GROUP THEORY- 25 Hours

Cyclic groups, The structure of cyclic groups, Sub groups of finite cyclic groups, Permutations, Permutation groups, Symmetric group S_3, Dihedral group D_4, Cayley's theorem. Orbits, Cycles, Even and Odd permutations, Alternating groups.

Chapters 6, 8, 9

MODULE 3: GROUP HOMOMORPHISMS- 25 Hours

Cosets, Lagrange's theorem, Homomorphism, Properties of homomorphism, Normal sub groups, Factor groups from homomorphisms, Factor groups from normal subgroups, The Fundamental Homomorphism Theorem, Normal subgroups and inner automorphisms.
Chapters 10, 13, 14

MODULE 4: RING THEORY– 20 Hours

Rings, Basic properties of Rings, Homomorphism and isomorphism, Fields, Divisors of zero and Cancellations, Integral domains, Characteristic of a Ring.
Chapters 18, 19

REFERENCES

1. I N HERSTEIN; TOPICS IN ALGEBRA, 2ND EDITION, JOHN WILEY 1975.
2. JOSEPH A GALLIAN; CONTEMPORARY ABSTRACT ALGEBRA, 7TH EDITION, BROOKS & COLE, 2010.
3. RONALD SOLOMON; ABSTRACT ALGEBRA (PURE AND APPLIED GRADUATE TEXTS) VOLUME 9, AMS 2003.
4. DAVID S DUMMIT & RICHARD M FOOTE; ABSTRACT ALGEBRA, 3RD EDITION, JOHN WILEY, 2004.

BBMM508: ENVIRONMENTAL ISSUES, HUMAN RIGHTS AND DIFFERENTIAL EQUATIONS

Total Hours: 108

Credit: 4

COURSE OBJECTIVE

- Provide a clear idea about the national and international perspectives of human rights.
- Enrich the students about the environmental issues that challenges the human existence.
- Provide an idea about the role of differential equations in environmental issues.

COURSE OUTCOME

- Appreciate the ethical, cross-cultural, and historical context of environmental issues and the links between human and natural systems.
- Understand the transnational character of environmental problems and ways of addressing them, including interactions across local to global scales.
- Appreciate human rights
- Appreciate concepts and methods from differential equations and their application in environmental problem solving.

MODULE 1: ENVIRONMENT AND ENVIRONMENTAL ISSUES - 23 Hours

Meaning and importance of environment; abiotic and biotic components; environment and development- Natural resources – renewable and non-renewable- concept of sustainable development

Pollution: air pollution; water pollution; soil pollution; noise pollution; marine pollution, solid waste management: causes, effects and control measures of urban and industrial waste - biodegradable and non-degradable; 3 R’s in waste management, Role of an individual in prevention of pollution.

Global warming and climate change; ozone depletion; greenhouse effect; acid rain; carbon trading, carbon credit; carbon sequestration; IPCC/UNFCC; nuclear accidents and nuclear holocaust, sand mining; wetland reclamation; landscape changes; deforestation; soil erosion. flood and drought, desertification, overexploitation, threats to fresh water resources of Kerala; tourism and its impact on environment.

MODULE 2: HUMAN RIGHTS - 23 Hours

National and International Perspectives: Definitions of Human Right, Relevance of Human Rights in India-Social Aspects-Economic Aspects-Political Aspects, Human Rights

International Norms, UDHR-Civil and political rights-Economic, social and cultural rights-Rights against torture, Discrimination and forced labour-Rights of the child, Human Rights and duties in India- Preamble to the Indian constitution-Human Rights and Duties in Indian constitution

Deprivation of Human Rights-The core issues: Poverty-Overpopulation-Illiteracy-Unsustainable Development, Disadvantageous Groups (Women, Children, SC/ST, Homeless and slum dwellers, physically and mentally handicapped, refugees and internally displaced persons.

Redressal Mechanisms against Human Rights Violation: Judiciary -Government systems for Redressal - NHRC and other Statutory Commissions-Media Advocacy-Creation of Human Rights Literacy and Awareness

MODULE 3: DIFFERENTIAL EQUATIONS I - 32 Hours

Role of Differential equations in environmental transport problems, Introduction to exact differentials and the Integrating Factor Methods, Bernoulli's equation, Example applications: Flow of water from dams, Atomic waste disposal in oceans, Refined logistic equations for population forecasting, Water movement in the soil-plant-atmosphere continuum using the electric circuit analogies.

MODULE 4: DIFFERENTIAL EQUATIONS II - 30 Hours

Linear Differential Equations of second order, Superposition principle, General solutions to homogenous equations with constant coefficients of order n, Example application: Ground water hydraulics

REFERENCES

1. AGARWAL, K.C. 2001: ENVIRONMENTAL BIOLOGY, NIDI PUBL. LTD. BIKANER.
2. BHARUCHAERACH: THE BIODIVERSITY OF INDIA, MAPIN PUBLISHING PVT. LTD., AHMEDABAD – 380 013, INDIA, EMAIL:MAPIN@ICENET.NET
3. BRUNNER R.C., 1989: HAZARDOUS WASTE INCINERATION, MCGRAW HILL INC.
4. CLARK R.S.: MARINE POLLUTION, CLANDERSON PRESS OXFORD
5. CUNNINGHAM, W.P. COOPER, T.H. GORHANI, E & HEPWORTH, M.T. 2001: ENVIRONMENTAL ENCYCLOPEDIA, JAICO PUBL. HOUSE, MUMBAI,

6. DE A.K.: ENVIRONMENTAL CHEMISTRY, WILEY EASTERN LTD.
7. GLEICK, H.P. 1993: WATER IN CRISIS, PACIFIC INSTITUTE FOR STUDIES IN DEV., ENVIRONMENT & SECURITY. STOCKHOLM ENV. INSTITUTE OXFORD UNIV. PRESS.
8. HAWKINS R.E.: ENCYCLOPEDIA OF INDIAN NATURAL HISTORY, BOMBAY NATURALHISTORY SOCIETY, BOMBAY
9. JADHAV, H & BHOSALE, V.M. 1995: ENVIRONMENTAL PROTECTION AND LAWS.HIMALAYA PUB. HOUSE, DELHI
10. MCKINNEY, M.L. AND SCHOOL, R.M. 1996. : ENVIRONMENTAL SCIENCE SYSTEMS & SOLUTIONS, WEB ENHANCED EDITION. 639P.
11. MHASKAR A.K.: MATTER HAZARDOUS, TECHNO-SCIENCE PUBLICATION
12. MILLER T.G. JR. ENVIRONMENTAL SCIENCE, WADSWORTH PUBLISHING CO.
13. RAO M N. ANDDATTA, A.K. 1987. WASTE WATER TREATMENT. OXFORD & IBH PUBL.CO. PVT. LTD. 345P.
14. SHARMA B.K., 2001: ENVIRONMENTAL CHEMISTRY. GEOL PUBL. HOUSE, MEERUT
15. TRIVEDI R.K., HANDBOOK OF ENVIRONMENTAL LAWS, RULES GUIDELINES: COMPLIANCES AND STANDARDS, VOL II, ENVIRO MEDIA AND I
16. TRIVEDI R. K. AND P.K. GOEL: INTRODUCTION TO AIR POLLUTION, TECHNO-SCIENCE PUBLICATION
17. WANGER K.D., 1998 ENVIRONMENTAL MANAGEMENT. W.B. SAUNDERS CO. PHILADELPHIA, USA
18. ROWAN CRUFT, S. MATTHEW LIAOAND MASSIMO RENZO, 2015: PHILOSOPHICAL FOUNDATIONS OF HUMAN RIGHTS, OXFORD UNIVERSITY PRESS,
19. ARYEHNEIER, 2012: THE INTERNATIONAL HUMAN RIGHTS MOVEMENT: A HISTORY; PRINCETON UNIVERSITY PRESS,
20. CARL WELLMAN, 2011: THE MORAL DIMENSIONS OF HUMAN RIGHTS;, OXFORD UNIVERSITY PRESS,
21. HELEN M. STACY, 2009: HUMAN RIGHTS FOR THE 21ST CENTURY: SOVEREIGNTY, CIVIL SOCIETY, CULTURE, STANFORD UNIVERSITY PRESS,

22. JEAN-MARC COICAUD; MICHAEL W. DOYLE; ANNE-MARIE GARDNER 2003: THE GLOBALIZATION OF HUMAN RIGHTS, UNITED NATIONS UNIVERSITY PRESS,
23. ANDREW CLAPHAM: HUMAN RIGHTS A VERY SHORT INTRODUCTION, OXFORD UNIVERSITY PRESS
24. RAMAN R P: HUMAN RIGHTS CONCEPTS AND CONCERNS, DC BOOKS, KOTTAYAM.
25. ABRAMOWITZ M & I A STEGUN, 1964: HANDBOOK OF MATHEMATICAL FUNCTIONS, DOVER, 1046PP
26. CODDINGTON E A, 1961: AN INTRODUCTION TO ORDINARY DIFFERENTIAL EQUATIONS, DOVER

SEMESTER VI

BBMM609: MATHEMATICAL ANALYSIS - IV

Total Hours: 90

Credit: 4

COURSE OBJECTIVES

- Have the knowledge about differential calculus for vector valued functions.
- Have the knowledge of integral calculus in several variables
- Have the knowledge of integration along curves and surfaces
- Have the knowledge Gauss theorem, Green Theorem and Stokes theorem and problems using these theorems.

COURSE OUTCOME

- Recognise Jacobian matrix, differential operators.
- Calculate integrals of multivariable functions.
- Calculate integrals along curves and manifolds
- Recognise Gauss theorem, Green Theorem and Stokes theorem and solve problems using these theorems.
- Understand power of mathematics in our life.

TEXT BOOK

1. CLAUDIO CANUTO, ANITA TABACCO, MATHEMATICAL ANALYSIS II, SPRINGER 2010

MODULE 1: DIFFERENTIAL CALCULUS FOR VECTOR VALUED FUNCTIONS - 25 Hours

Partial derivatives and Jacobian matrix, Differentiability and Lipchitz functions, Basic differential operators, First Order operators, second order operators, differentiating composite functions, Functions defined by integrals. Inverse and Implicit Function Theorems (Statement only)

Section 6.1-6.4.1

MODULE 2: INTEGRAL CALCULUS IN SEVERAL VARIABLES - 25 Hours

Double integral over rectangles, Double integrals over measurable sets, properties of double integrals, changing variables in double integrals, Multiple integrals, Changing variables in

triple integrals, applications and generalizations, mass, centre of mass and moments of a solid body, volume of solids of revolution, integrals of vector valued functions, improper multiple integrals.
Section 8.1-8.5.4

MODULE 3: INTEGRAL CALCULUS ON CURVES AND SURFACES - 20 Hours

Integrating along curves, centre of mass and moments of a curve, path integrals, integrals over surfaces, area of a surface, centre of mass and moments of a surface, flux integrals.
Section 9.1-9.4

MODULE 4: THEOREMS OF GAUSS, GREEN AND STOKES - 20 Hours

Open sets, admissible surfaces and boundaries, divergence theorem, Green's theorem, Stokes theorem, Conservative fields and potentials, computing potentials explicitly.
Section 9.5-9.6.1

REFERENCES

1. HORST R BAYER: CALCULUS AND ANALYSIS: A COMBINED APPROACH. (WILEY), 2010.
2. T. M. APOSTOL: CALCULUS VOLUME I & II (WILEY), 1991.
3. A. D. ALEXANDROV ET AL: MATHEMATICS, ITS CONTENT, METHODS AND MEANING, DOVER, 1999.
4. W. RUDIN: PRINCIPLES OF MATHEMATICAL ANALYSIS, SECOND EDITION, MCGRAW-HILL, 1964
5. A. E. TAYLOR: GENERAL THEORY OF FUNCTIONS AND INTEGRATION, DOVER, 2010.

BBMM610: COMPLEX ANALYSIS

Total Hours: 90

Credit: 4

COURSE OBJECTIVES

- Aims to introduce the notion of functions on complex variables, analyticity, harmonic functions and contour integration.
- Develop the geometric understanding of functions on one complex variable.
- Series representation of complex functions and the evaluation of singular points and residues.

COURSE OUTCOMES

- Understanding the complex numbers geometrically and algebraically
- Understanding the notion of limit, continuity, derivatives on functions of one complex variables
- Series representation of complex functions and evaluating the residues
- Contour integration to evaluate the complicated real integrals via residue calculus. Ability to pursue further studies in the field

TEXT BOOK

1. DENNIS G ZILL AND PATRIK D SHANAHAN: A FIRST COURSE IN COMPLEX ANALYSIS WITH APPLICATIONS (SECOND EDITION), JONES AND BARTLETT PUBLISHERS, 2007

MODULE 1: COMPLEX FUNCTIONS AND MAPPINGS – 25 hours

Complex Functions, Complex Functions as Mappings, Linear Mappings, Special Power Functions, Reciprocal Function, Limits and Continuity, Applications

Section 2.1 - 2.7

MODULE 2: ANALYTIC FUNCTIONS AND ELEMENTARY FUNCTIONS – 25 Hours

Differentiability and Analyticity, Cauchy-Riemann Equations, Harmonic Functions, Applications, Exponential and Logarithmic Functions, Complex Powers, Trigonometric and Hyperbolic Functions.

Section 3.1 - 3.4; 4.1 - 4.3

MODULE 3: INTEGRATION IN THE COMPLEX PLANE – 20 Hours

Real Integrals, Complex Integrals, Cauchy-Goursat Theorem, Independence of Path, Cauchy's Integral Formula and Their Consequences, Applications.

Section 5.1-5.6

MODULE 4: SERIES AND RESIDUES AND CONFORMAL MAPPINGS – 20 hours

Sequences and Series, Taylor Series, Laurent Series, Zeros and Poles, Residues and Residue Theorem, Some Consequences of Residue Theorem, Applications, Conformal Mappings and Linear Fractional Transformations.

Section 6.1 - 6.7; 7.1 - 7.2)

REFERENCES

1. LARS V. AHLFORS: COMPLEX ANALYSIS- AN INTRODUCTION TO THE THEORY OF ANALYTIC FUNCTIONS OF ONE COMPLEX VARIABLE (4TH ED.), MCGRAW-HILL, 1953.
2. JAMES WARD BROWN AND RUEL V CHURCHILL: COMPLEX VARIABLES AND APPLICATIONS (8TH EDITION), 2008
3. J. M. HOWIE: COMPLEX ANALYSIS, SPRINGER, 2003

BBMM611: DISCRETE MATHEMATICS

Total Hours: 90

Credit: 4

COURSE OBJECTIVE

- To define how graphs serve as models for many standard problems.
- To discuss the concepts of graphs, trees, Eulerian graphs, combinatorics and Boolean algebra.

COURSE OUTCOME

- Define and relate basic notions in graph theory. To apply algorithms and theorems in graph theory in solving real life problems such job assignment, colouring etc
- Describe and solve real world problems using concepts of combinatorics.

TEXT BOOKS

1. REINHARD DIESTEL, GRAPH THEORY, SECOND EDITION, SPRINGER, 1997
2. C.L LIU-ELEMENTS OF DISCRETE MATHEMATICS, MC GRAW –HILL, 2012
3. CHEN CHUAN CHONG, KOH KHEE MENG, PRINCIPLES AND TECHNIQUES IN COMBINATORICS (WORLD SCIENTIFIC), 1992

MODULE 1: GRAPH THEORY I – 25 Hours

The basics, Graphs, the degree of a vertex, Paths and cycles, Connectivity, Trees and forests

Text Book 1 - Chapter 1 Sections 1.1 - 1.5

MODULE 2: GRAPH THEORY II – 25 Hours

Bipartite graphs, Contraction and minors, Euler tours, Matching in bipartite graphs.

Textbook 1 - Chapter 1 -Sections 1.6– 1.8

Chapter 2- Section 2.1

MODULE 3: BOOLEAN ALGEBRAS – 20 Hours

Introduction, Properties of Binary relation, Equivalence relations and partitions, Partial order relations and Lattices, Chains and Antichains, Lattices and Algebraic Systems, Principle of duality, Basic properties of Algebraic systems defined by lattices, Modular, Distributive complete and Complemented lattices, Boolean lattices and Boolean Algebras, Uniqueness of finite Boolean Algebras.

Text book 2 - Chapter 4 - Sections 4.1, 4.3, 4.4, 4.5, 4.6

Chapter 12 - Sections 12.1, 12.2, 12.3, 12.4, 12.5, 12.6

MODULE 4: COMBINATORICS – 20 Hours

Two basic counting principles, Permutations, Circular permutations, Combinations, The injection and bijection principles, Arrangements and selection with repetitions, Introduction to principle of inclusion and exclusion, The principle-A generalization.

Text Book 3 - Chapter 1- sections 1.1-1.6; 3.1, 3.2

REFERENCES

1. JOHN CLARK & DEREK ALLEN HOLTEN: A FIRST LOOK AT GRAPH THEORY-ALLIED PUBLISHERS, 1991.
2. R BALAKRISHNAN & K RANGANATHAN : A TEXT BOOK OF GRAPH THEORY-SPRINGER EDITION, 2000
3. DOUGLAS B. WEST-INTRODUCTION TO GRAPH THEORY, SECOND EDITION (PEARSON EDUCATION), 2001
4. VIJAY KHANNA : LATTICES AND BOOLEAN ALGEBRAS-FIRST CONCEPTS – VIKAS PUBLISHING HOUSE, 2001

BBMM612: METRIC SPACES

Total Hours: 90

Credit: 4

COURSE OBJECTIVES

- Introduce the basic ideas of metric spaces.
- Illustrate them with a wealth of examples and applications.
- Relevant to all course units involving advanced calculus or topology.
- Introduction to normed linear spaces.

COURSE OUTCOMES

- Define several standard examples of metric spaces and prove simple results related to them.
- Determine whether a given metric space has any of the properties: openness, closedness
- Prove simple results related to all of the above notions

TEXT BOOK

1. MICHEAL O SEARCOID: METRIC SPACES, SPRINGER 2007

MODULE 1: METRICS - 20 Hours

Metric Spaces, Point Functions and Point like Functions, Metric Subspaces and Metric Super spaces, Isometries, Extending a Metric Space, Metrics and Norms on Linear Spaces

Chapter 1 Sections 1.1-1.5, 1.7 (excluding section 1.6)

MODULE 2: DISTANCE - 20 Hours

Diameter, Distances from Points to Sets, Inequalities for Distances, Distances to Unions and Intersections, Isolated Points, Accumulation Points, Distances from Sets to Sets.

Chapter 2 (excluding section 2.8)

MODULE 3: OPEN AND CLOSED SETS - 25 Hours

Boundary Points, Sets with Empty Boundary, Boundary Inclusion, Boundaries in Subspaces and Super spaces, Boundaries of Unions and Intersections, Closure and Interior, Inclusion of Closures and Interiors, Closure and Interior of Unions and Intersections, Open and Closed Subsets, Dense Subsets

Chapter 3

Chapter 4 Sections 4.1-4.2

MODULE 4: CONVERGENCE - 25 Hours

Open and Closed Balls, Theorems using Balls, Balls in Normed Linear Spaces, Definition of Convergence for Sequences, Limits, Superior and Inferior Limits of Real Sequences, Convergence in Subspaces and Super spaces, Convergence Criteria for Interior and Closure

Chapters 5 (excluding section 5.3)

Chapter 6 Sections 6.1-6.4, 6.6 (excluding sections 6.5)

REFERENCES

1. G. F. SIMMONS: AN INTRODUCTION TO TOPOLOGY AND MODERN ANALYSIS, 1963
2. W. A. SUTHERLAND: INTRODUCTION TO METRIC AND TOPOLOGICAL SPACES, 2009
3. E. KREYSZIG: INTRODUCTORY FUNCTIONAL ANALYSIS WITH APPLICATIONS, 2007
4. SATISH SHIRALI, HARKISHAN LAL VASUDEVA: METRIC SPACES SPRINGER SCIENCE & BUSINESS MEDIA, 2006

ELECTIVE COURSES

BBMM6E01: OPERATIONS RESEARCH

Total Hours: 90

Credit: 4

COURSE OBJECTIVES

- To understand the theory of optimization methods and algorithms developed for solving various types of linear programming problems.
- To understand the strength and weakness of queuing models.

COURSE OUTCOME

- Able to formulate optimization problems. Achieve knowledge about techniques that can be used to solve such problems
- Able to model and analyze the real world queuing systems.

TEXT BOOKS:

1. K. V MITAL AND C. MOHAN: OPTIMIZATION METHODS IN OPERATIONS RESEARCH AND SYSTEM ANALYSIS (3^{RD} EDITION) (NEW AGE INTERNATIONAL), 1996.
2. J. K. SHARMA: OPERATION RESEARCH THEORY AND APPLICATION (3^{RD} EDITION), 2006.

MODULE 1: MATHEMATICAL PRELIMINARIES – 25 Hours

Euclidean Space: Vectors and vector space Linear dependence, dimensions of a vector space, basis.

Convex sets : Open and closed sets in E_n, convex linear combinations, convex sets, intersection of convex sets, convex hull of a set, vertices of a convex set, convex polyhedron, hyper planes, half spaces and polytopes, separating and supporting hyper planes, (All Theorems without proof)

Linear Programming Introduction, LP in two dimensional space, general LPP, Feasible solution, Basic and basic feasible solution, optimal solution.

Ch. 1 (Section 1 – 5 and 11 – 18 of text 1)

MODULE 2: LINEAR PROGRAMMING CONTD – 20 Hours

Simplex method (numerical example) Simplex tableau, Finding the first b.f. s., artificial variables, Degeneracy, simplex multipliers, Duality in LPP, Duality theorems, Application of duality, Dual simplex method.

Ch. 3 (Section 1 – 20 except 16 of text 1)

MODULE 3: TRANSPORTATION AND ASSIGNMENT PROBLEMS - 25 Hours

Introduction, transportation problem, Transportation array, Transportation matrix, triangular basis, finding a basic feasible solution, testing of optimality, loop in a transportation problem, change the basis, Degeneracy, Unbalanced problem, Assignment problem.

Ch. 4 (Section 1 – 11 & 14 of text 1)

MODULE 4: QUEUING THEORY - 20 Hours

Introduction, Essential features of queuing system, Calling population, Characteristic Queuing Process, Queue discipline, Service Process (or Mechanisms) , Performance measure of Queuing system. Transient- state and Steady – state, Relationship among Performance measure. Probability distribution in Queuing system, Distribution of arrival (Pure Birth Process), Distribution of inter-arrival times (Exponential process) Distribution of departure (Pure Death Process) Distribution of Service Times.

Ch. 16 (Section 16.1 – 16.4 of text 2)

REFERENCES:

1. KANTI SWARUP, P. K. GUPTA AND MAN MOHAN: OPERATION RESEARCH, SULTAN CHAND AND SONS, 1997.
2. GUPTA P. K. AND HIRA D. S.: PROBLEMS IN OPERATIONS RESEARCH, S. CHAND, 1991
3. RAVINDRAN A., PHILIP D. T. AND SOLBERG J. J.: OPERATIONS RESEARCH, JOHN WILEY AND SONS, 1987.
4. MOKHTAR S. BAZARAA, J. J. JARVIS, H.D. SHERALI: LINEAR PROGRAMMING AND NETWORK FLOWS, WILEY INDIA, 2011.

BBMM6E02: PROGRAMMING IN C

Total Hours: 90

Credit: 4

COURSE OBJECTIVES

- Provide exposure to problem solving through programming.
- Train the student to the basic concepts of the C programming language
- Give the student hands-on experience with the concepts

COURSE OUTCOMES

- Identify situations where computational methods and computers would be useful.
- Write the program on a computer, edit, compile, debug, correct, recompile and run it.
- Choose the right data representation formats based on the requirements of the problem

TEXT BOOK

1. E. BALAGURUSAMY - PROGRAMMING IN ANSI C, FOURTH EDITION, THE TATA MC GRAW - HILL PUBLISHING COMPANY,2008.

MODULE 1: CONSTANTS VARIABLES AND DATA TYPES - 20 Hours

Introduction, Character set, C Tokens, Keywords and Identifiers, Constants, Variables, Data Types, Declaration of Variables, Declaration of Storage Class, Assigning Values to Variables, Defining Symbolic Constants, Declaring a Variable as Constant, Declaring a Variable as Volatile, Overflow and Underflow of Data,

Operators and Expressions.

Introduction, Arithmetic Operators, Relational Operators, Logical Operators, Assignment Operators, Increment and Decrement Operators, Conditional Operator, Bitwise Operators, Special Operators, Arithmetic Expressions, Evaluation of Expressions, Precedence of Arithmetic Operators, Some Computational Problems, Type Conversions in Expressions, Operator Precedence and Associativity, Mathematical Functions

Managing Input and Output Operations.

Introduction, Reading a Character, Writing a Character, Formatted Input, Formatted Output.

Chapter 2, Chapter 3 and Chapter 4

MODULE 2: DECISION MAKING AND BRANCHING - 20 Hours

Introduction, Decision Making with IF Statement, Simple IF Statement, the IF……Else Statement, Nesting of IF……Else Statement, the Else…….IF Ladder, The switch Statement, The? **:** Operator the GOTO Statement

Decision Making and Looping

Introduction, the WHILE Statement, the DO Statement, the FOR Statement, Jumps in LOOPS, Concise Test Expressions

Chapter 5 and Chapter 6

MODULE 3 ARRAYS - 25 Hours

Introduction, One Dimensional Arrays, Declaration of One Dimensional Arrays, Initialization of One Dimensional Arrays, Two Dimensional Arrays, Initialization of Two Dimensional Arrays, Multidimensional Arrays, Dynamic Arrays, More about Arrays.

Declaring and Initializing String Variables, Reading Strings from Terminal, Writing Strings to Screens. Arithmetic Operations on Characters, Putting Strings together, Comparison of two Strings, String Handling Functions. Table of Strings, Other Features of Strings

MODULE 4: USER DEFINED FUNCTIONS – 25 Hours

Introduction, Need for User Defined Functions, A Multi Function Programme, Elements of User Defined Functions, Definition of Functions, Return Values and their Types, Function Calls, Function Declaration, Category of Functions, No Arguments and No Return Values, Arguments but No Return Values, Arguments with return Values, No Arguments but Returns a Value, Functions That Return Multiple Values, Nesting of Functions, Recursions, Passing Arrays to Functions, Passing Strings to Functions, The scope, Visibility and Lifetime of Variables, Multi File Programmes

Chapter 7, Chapter 8 and Chapter 9

REFERENCES

1. V. RAJARAMAN: COMPUTER PROGRAMMING IN C, PRENTICE HALL OF INDIA, PVT LTD, 1972.
2. BYRON S GOTTRIED: THEORY AND PROBLEMS OF PROGRAMMING WITH C, (SCHAUMS) TATA MC GRAW – HILL, 2011.
3. YASHWANTH P KANETHKAR: LET US C, BPB PUBLICATIONS, 2016.

BBMM6E03: TOPOLOGY

Total Hours: 90

Credit: 4

COURSE OBJECTIVES

- Provide for the students an introduction to theory of topological spaces with emphasis on those topics that are important to higher mathematics.
- Focuses on the basic notions of topological spaces, properties of continuous mappings, topological properties like compactness and connectedness and basic theorems on topological spaces.

COURSE OUTCOMES

- Understand terms, definitions and theorems related to topology.
- Demonstrate knowledge and understanding of concepts such as open and closed sets, interior, closure and boundary.
- Create new topological spaces by using subspace, product and quotient topologies.
- Use continuous functions to understand structure of topological spaces.

TEXT BOOKS

1. JAMES R MUNKRES: TOPOLOGY- SECOND EDITION, PEARSON PRENTICE HALL, AN IMPRINT OF PEARSON EDUCATION (FIRST IMPRESSION, 2006)

MODULE 1: INTRODUCTION TO TOPOLOGY -20 Hours

Topological Spaces, Basis for a Topology, The product Topology on XY, The Subspace Topology.

MODULE 2: CONTINUOUS FUNCTIONS - 25 Hours

Closed sets and Limit Points, Continuous functions, The Metric Topology

MODULE 3: CONNECTED SPACES - 25 Hours

Connected Spaces, Connected subspaces in the Real Line

MODULE 4: COMPACT SPACES - 20 Hours

Compact Spaces

Chapter – 2: Sections 12, 13, 15, 16, 17, 18, 20

Chapter – 3: Sections 23, 24, 26

REFERENCE

1. G. F. SIMMONS, INTRODUCTION TO TOPOLOGY AND MODERN ANALYSIS, 1963

BBMM6E04: THEORY OF COMPUTATION

Total Hours: 90

Credit: 4

COURSE OBJECTIVES

- Define formal mathematical models of computation, and study their relationships with formal languages.
- Learn several formal mathematical models of computation along with their relationships with formal languages.
- Learn regular languages and context free languages

COURSE OUTCOMES

- Apply knowledge of computing and mathematics appropriate to the discipline.
- Apply mathematical foundations, algorithmic principles and computer science theory to the modeling and design of computer based systems in a way that demonstrates

TEXT BOOK:

1. K.L.P. MISHRA AND N.CHANDRASEKARAN - THEORY OF COMPUTER SCIENCE, AUTOMATA, LANGUAGES AND COMPUTATION (THIRD EDITION), PRENTICE- HALL OF INDIA PVT. LTD, NEW DELHI, 2006

MODULE 1: INTRODUCTION TO THEORY OF AUTOMATA - 25 Hours

The Theory of Automata: Definition of Automaton – Description of Finite Automaton – Transition Systems – Properties of Transition Functions – Acceptability of a String by a Finite Automaton – Nondeterministic Finite State Machines – The Equivalence of DFA and NDFSA. Examples.

MODULE 2: FORMAL LANGUAGES - 20 Hours

Formal Languages: Basic Definitions – Definition of a Grammar – Derivations and Language Generated by a Grammar – Examples

MODULE 3: LANGUAGES - 20 Hours

Chomsky Classification of Languages – Languages and their relation – Operation on Languages – Languages and Automata - Examples

MODULE 4: REGULAR EXPRESSIONS - 25 Hours

Regular expressions – Identities for Regular Expressions – Finite Automata and Regular Expressions – Transition system Containing - moves- NDFAs with - moves and Regular Expressions – Conversion of Nondeterministic Systems to Deterministic Systems – Algebraic Method Using Arden's Theorem - Construction of Finite Automata Equivalent to a Regular Expression – Equivalence of Two Finite Automata – Equivalence of Two Regular Expressions. Examples

Chapters – 3, 3.1- 3.7, 4.1, 4.2, 4.3, 4.6, 5.1 and 5.2 (Proof of theorems 5.1, 5.2, 5.3 and 5.4 are omitted)

REFERENCES

1. JOHN E. HOPCROFT, JEFREY D. ULLMAN: INTRODUCTION TO AUTOMATA THEORY LANGUAGES, AND COMPUTATION, NAROSA PUBLISHING HOUSE 1999
2. PETER LINZ: AN INTRODUCTION TO FORMAL LANGUAGES AND AUTOMATA (SECOND EDITION) NAROSA PUBLISHING HOUSE 1997.

BBMM6E05: NUMERICAL METHODS

Total Hours: 90

Credit: 4

COURSE OBJECTIVES

- Provide participants with the skills, knowledge and attitudes required to determine approximate numerical solutions to mathematical problems which cannot always be solved by conventional analytical techniques
- Demonstrate the importance of selecting the right numerical technique for a particular application, and carefully analysing and interpreting the results obtained.

COURSE OUTCOMES

- Analyse the errors obtained in the numerical solution of problems.
- Using appropriate numerical methods, determine the solutions to given non-linear equations.
- Using appropriate numerical methods, determine approximate solutions to ordinary differential equations.
- Demonstrate the use of interpolation methods to find intermediate values in given graphical and/or tabulated data.

TEXT BOOKS:

1. E. BALAGURUSAMY: TREATMENT AS IN NUMERICAL METHODS, TATA MCGRAW HILL, 2012.
2. BERNARD CHILD: HIGHER ALGEBRA, AITBS PUBLISHERS, INDIA, 2008
3. P. KANDASAMY, .THILAGAVATHY AND K.GUNAVATHY: NUMERICAL METHODS, S.CHAND AND COMPANY LTD, 2008

MODULE 1: APPROXIMATIONS AND ERRORS IN COMPUTING - 20 Hours

Approximations and errors in computing – significant digits – Inherent errors – Numerical errors – Truncation errors – Modelling errors – Blunders – Absolute and Relative errors. Error Propagation - conditioning and Stability – Convergence of an iterative process – Error estimation – Minimizing the total error.

Theory of equations Statement of fundamental Theorem of algebra. Deduction that every polynomial of degree n has only n roots. Relation between roots and coefficients.

Transformation of equations. Reciprocal equations. Cardan's method, Ferrari's method. Symmetric functions of roots.
(Chapter 6 and Descartes Rule of signs also, 11, 12 of Text 2)

MODULE 2: LINEAR AND NON LINEAR EQUATIONS- 20 Hours

Roots of non – Linear equations – methods of solution – Iterative methods – Starting and stopping an iterative process. – Bisection Method – Convergence of bisection method – False position method – convergence – Newton – Raphson method – convergence – Limitations - Secant Method – convergence

Solutions to simultaneous linear equations – Existence of solution – Solution by elimination – Basic Gauss Elimination Method – Gauss Elimination with Pivoting - Guass Jordan method – Triangular Factorization Methods – Matrix Inversion method.

Iterative solutions of Linear Equations - Gauss Jocobis Iteration method – Gauss - Seidal iterative method – Method of Relaxation – convergence of iteration methods.

MODULE 3: INTERPOLATION - 25 hours

Curve Fitting: Interpolation – Polynomial forms – Linear Interpolation – Lagrange Interpolation polynomial – Newton Interpolation polynomial – Divided difference table – Interpolation with equidistant points – Forward and Backward difference table

Curve Fitting: Regression –Fitting Linear equations –Least squares regression – Fitting Transcendental Equations – Fitting a polynomial function

MODULE 4: NUMERICAL DIFFERENTIATION AND NUMERICAL INTEGRATION – 25 Hours

Numerical Differentiation – Differentiating Continuous functions – Forward and central difference quotient – Error Analysis – Differentiating Tabulated functions - Higher – order derivatives.

Numerical Integration – Newton – Cotes methods – Trapezoidal Rule – Error analysis – Composite Trapezoidal rule - Simpsons 1/3 rule – Error analysis – Composite Simpsons 1/3 rule – Error analysis – Simpsons 3/8 rule – Boole's rule

Numerical Solution of Ordinary Differential equations – Taylor Series method – Picard's method – Euler's Method – Accuracy of Euler's method – Polygon method – Runge –Kutta Methods.

REFERENCES

1. M.K.VENKATARAMAN, NUMERICAL METHODS IN SCIENCE AND ENGG, NATIONAL PUBLISHING COMPANY 1990
2. DUCHATEAU P C, ADVANCED MATH FOR ENGINEERS AND SCIENTISTS, HARPER COLLINS COLLEGE OUTLINE, 1992.

COMPLEMENTARY COURSES IN MATHEMATICS FOR UNDERGRADUATE PROGRAMME IN PHYSICS

SEMESTER I

BDMP101: MATHEMATICS FOR PHYSICS – I

Total Hours: 72

Credit: 3

COURSE OBJECTIVE

- To impart knowledge about various mathematical tools employed to study physics problems.
- Better understanding of matrices and matrix algebra.
- To acquire basic knowledge of curve and surfaces.
- Understand the basic theory of differential and integral calculus.
- Better understanding of basic concepts of probability and statistics

COURSE OUTCOME

- Refine geometrical problem-solving and analysis skills and relate them to existing body of knowledge in mathematics, physics, and engineering.
- Use Gauss-Jordan elimination to solve systems of linear equations and to compute the inverse of an invertible matrix.
- Able to work with multivariable functions.

TEXT BOOKS

1. FRANK AYRES JR, MATRICES, SHAUM'S OUTLINE SERIES, THIRD EDITION, 1974
2. THOMAS AND FINNEY, CALCULUS AND ANALYTIC GEOMETRY, NINTH EDITION, PEARSON, 2002
3. GEORGE B. THOMAS, JR: THOMAS' CALCULUS ELEVENTH EDITION, PEARSON, 2008.
4. S.C. GUPTA AND V.K. KAPOOR: FUNDAMENTALS OF MATHEMATICAL STATISTICS, SULTAN CHAND AND SONS, 1997.

MODULE 1: MATRICES - 18 Hours

Rank of a matrix, Row canonical form, Normal form, Elementary matrices, System of linear equations, Solutions by matrix method, Crammer's Rule, Characteristic equation of a matrix,

Characteristic roots and vectors, Cayley Hamilton Theorem (Statement only) and Simple Applications.

Text Book 1- Chapter 5,10,19,23.

MODULE 2: CURVES AND SURFACES - 18 Hours

Circle, Parabola, Ellipse, Hyperbola, Classifying Conic sections by eccentricity, Parameterization of Plane Curves, Cylinders and Quadric Surfaces, Cylindrical and Spherical coordinates.

Text Book 2 – Sections 9.1, 9.2, 9.4; Section 10.6-10.7.

MODULE 3: DIFFERENTIAL AND INTEGRAL CALCULUS - 18 Hours

Functions of Several Variables, Partial Derivatives. Area between curves, Volumes by slicing and rotations about an axis (Disc Method only), Length of Plane Curves , Areas of Surfaces of Revolution, Double Integrals, Double Integrals in Polar Form, Triple Integrals in Rectangular Form)

Text Book 3- Section 14.3, Section 6.1, 6.3, 6.5, 15.1, 15.2, 15.3.

MODULE 4: PROBABILITY AND STATISTICS - 18 Hours

Introduction to Statistics, Methods of Sampling (Definitions only), Types of Data, Levels of measurement –Classification and Tabulation, Diagrammatic representation, Graphical representation.

Measures of Central Tendency, Absolute and Relative measures of Dispersion - Range, Quartile Deviation, Percentiles, Deciles, Box Plot, Mean Deviation, Standard Deviation, Coefficient of Variation.

Probability Concepts, Random Experiment, Sample Space, Events – Mutually exclusive, exhaustive, equally likely events. Approaches to Probability- Classical, Statistical and Axiomatic. Addition Theorem of probability for two, three and n events (with proof), Boole’s inequality. Conditional Probability, Independence of events, Multiplication theorem (upto 3 events).Total Probability Law, Baye’s Theorem.

Text Book 4- Relevant Sections

REFERENCES

1. DAVID W. LEWIS: MATRIX THEORY (ALLIED), 1991

2. ERWIN KREYSZIG: ADVANCED ENGINEERING MATHEMATICS – 8TH EDITION WILEY INDIA, 2007.
3. K F RILEY AND M P HOBSON: ESSENTIAL MATHEMATICAL METHODS FOR PHYSICAL SCIENCES, CAMBRIDGE UNIVERSITY PRESS, 2011

Question Paper Pattern.

The following guidelines shall be followed during question paper setting.

Module	Part A	Part B	Part C
I	4	3	1
II	3	3	1
III	3	2	1
IV	2	1	1
Total	**12**	**9**	**4**

SEMESTER II

BDMP202: MATHEMATICS FOR PHYSICS – II

Total Hours: 72

Credit: 3

COURSE OBJECTIVES

- The purpose of the course is to provide an understanding of the basic relations of vector analysis, to demonstrate practical applications of vector analysis and to train the student in problem formalization and in methods of solution.
- To give students an understanding of discrete Fourier series and integral Fourier and inverse-Fourier transforms, and provide students with practice in their application and interpretation in a range of situations.

COURSE OUTCOMES

- Analyse the integral ideas of the functions defined including line, surface and volume integrals - both derivation and calculation in rectangular, cylindrical and spherical coordinate systems and understand the proofs of each instance of the fundamental theorem of calculus.
- Find Fourier Series and Fourier transforms of periodic functions.

TEXT BOOKS

1. ERWIN KREYSZIG ADVANCED ENGINEERING MATHEMATICS, 8^{TH} EDITION, WILEY, 2007.

MODULE 1: VECTOR DIFFERENTIAL CALCULUS - 18 Hours

Vector Algebra in 2-space and 3-space, Inner Product, Vector Product, Vector and Scalar Functions and Fields, Derivatives, Curves, Tangents, Arc Lengths, Gradient of a Scalar Field, Directional Derivative, Divergence of a Vector field, Curl of a vector field.

Text Book 1-Chapter 8, Sections 8.1-8.5, 8.9-8.11

MODULE 2: VECTOR INTEGRAL CALCULUS - 18 Hours

Line integrals, Line integrals, Independence of Path, Green's Theorem in the Plane (Theorem without Proof), Surfaces for Surface Integrals, Triple Integrals, Divergence Theorem of Gauss, Further Applications of Divergence Theorem, Stoke's Theorem (without proof).

Text Book 1 – Chapter 9, Sections 9.1-9.9.

MODULE 3: FOURIER SERIES - 18 Hours

Periodic Functions, Trigonometric Series, Fourier Series, Functions of any period P=2n, even and odd functions, Half Range expansions.

Text Book 1 Chapter 10- Sections 10.1-10.4

MODULE 4: FOURIER TRANSFORMS - 18 Hours

Fourier Integrals, Fourier Cosine and Sine transform, Fourier Transform.

Text Book 1 – Chapter 10, Sections 10.8-10.10

REFERENCES

1. GEORGE B. THOMAS, JR: THOMAS' CALCULUS TWELTH EDITION, PEARSON, 2016
2. K F RILEY AND M P HOBSON: ESSENTIAL MATHEMATICAL METHODS FOR PHYSICAL SCIENCES, CAMBRIDGE UNIVERSITY PRESS, 2011.
3. P.P.G DYKE: AN INTRODUCTION TO LAPLACE TRANSFORMS AND FOURIER SERIES, SPRINGER, 2005.
4. B. S GREWAL, HIGHER ENGINEERING MATHEMATICS, KHANNA PUBLISHERS, NEW DELHI, 1996.

Question Paper Pattern

The following guidelines shall be followed during question paper setting.

Module	Part A	Part B	Part C
I	4	2	2
II	3	3	1
III	2	2	1
IV	3	2	0
Total	**12**	**9**	**4**

SEMESTER III

BDMP303: MATHEMATICS FOR PHYSICS – III

Total Hours: 90

Credit: 4

COURSE OBJECTIVES

- To expose the students to the basic ideas of differential equations combined with some ideas from linear algebra.
- Able to perform basic algebraic manipulation with complex numbers and to understand the geometric interpretation of complex numbers.
- To provide an introduction to the theories for functions of a complex variable. It begins with the exploration of the algebraic, geometric and topological structures of the complex number field. The concepts of analyticity, Cauchy-Riemann relations and harmonic functions are then introduced.

COURSE OUTCOMES

- Represent complex numbers algebraically and geometrically,
- Define and analyze limits and continuity for complex functions as well as consequences of continuity,
- Evaluate complex contour integrals directly and by the fundamental theorem, apply the Cauchy integral theorem in its various versions, and the Cauchy integral formula, and
- Represent functions as Taylor, power and Laurent series, classify singularities and poles, find residues and evaluate complex integrals using the residue theorem.
- Solve differential equations of first order using graphical, numerical, and analytical methods,
- Solve and apply linear differential equations of second order (and higher),
- Solve linear differential equations using the Laplace transform technique,
- Find power series solutions of differential equations

TEXT BOOKS

1. A. H SIDDIQI, P MANCHANADA: A FIRST COURSE IN DIFFERENTIAL EQUATIONS WITH APPLICATIONS, MACMILLAN INDIA LTD, 2006.

2. ERWIN KREYSZIG ADVANCED ENGINEERING MATHEMATICS, 8TH EDITION, WILEY, 2007.

MODULE 1: ODE I - 25 Hours

Exact Differential Equation, Linear Equations , Solutions by Substitutions, Equations of first order and not of first degree , First order equations of higher degree solvable for p, Equations solvable for y , Equations solvable for x, Equations of first degree in x and y, Lagrange's and Clairaut's Equations.

Text Book 1: Sections 2.1-2.4; 3.1- 3.5

MODULE 2: ODE II - 20 Hours

Homogenous Linear Equations with constant coefficients, Method of undetermined coefficients.

Numerical solutions to ordinary differential equations- Solution by Taylor series, Picard's method of successive approximations.

Text Book 1-Sections 5.5-5.6; 10.1-10.4

MODULE 3: COMPLEX ANALYSIS I - 25 Hours

Complex Numbers, Complex Plane, Polar Form of Complex Numbers, Powers Roots, Derivative, Analytic Functions, Cauchy Riemsnn Equations, Laplace's Equations.

Text Book 2: Chapter 12-Sections 12.1-12.4.

MODULE 4: COMPLEX ANALYSIS II - 20 Hours

Line integral in the complex plane, Cauchy's integral theorem- Cauchy's integral formula, derivatives of analytic functions, singularities and zeros, residue integration method

Text Book 2: Chapter 13

Chapter 15; 2-3

REFERENCES

1. K F RILEY AND M P HOBSON, ESSENTIAL MATHEMATICAL METHODS FOR PHYSICAL SCIENCES, CAMBRIDGE UNIVERSITY PRESS, 2011.
2. R. K. GHOSH, K. C. MAITY – AN INTRODUCTION TO DIFFERENTIAL EQUATIONS, NEW CENTRAL BOOKS, 2010.
3. SHEPLEY L. ROSS – DIFFERENTIAL EQUATION, WILEY INDIA, 2007.

4. B. S GREWAL, HIGHER ENGINEERING MATHEMATICS, KHANNA PUBLISHERS, NEW DELHI, 1996.

Question Paper Pattern

The following guidelines shall be followed during question paper setting.

Module	Part A	Part B	Part C
I	4	3	1
II	3	2	1
III	4	1	1
IV	1	3	1
Total	**12**	**9**	**4**

SEMESTER IV

BDMP404: MATHEMATICS FOR PHYSICS – IV

Total Hours: 90

Credit: 4

COURSE OBJECTIVES

- Partial differential equations allow deterministic mathematical formulations of phenomena in physics and engineering as well as biological processes among many other scenarios
- To present the main results in the context of partial differential equations that allow learning about these models and to study numerical methods for the approximation of their solution.
- To determine types of PDEs which may be solved by application of special functions.
- To study about the basic structures known as groups and the symmetry.

COURSE OUTCOME

- Be familiar with the modeling assumptions and derivations that lead to PDEs,
- Recognize the major classification of PDEs and the qualitative differences between the classes of equations
- Be competent in solving linear PDEs using classical solution methods.
- Verify group properties in particular examples.
- Recall and use the definitions and properties of cosets and subgroups.

TEXT BOOKS

1. IAN SNEDDON: ELEMENTS OF PARTIAL DIFFERENTIAL EQUATIONS, MCGRAW-HILL BOOK COMPANY, 2004.
2. ERWIN KREYSZIG ADVANCED ENGINEERING MATHEMATICS, 8^{TH} EDITION, WILEY, 2007.
3. JOHN B FRALEIGH- A FIRST COURSE IN ABSTRACT ALGEBRA, 7TH EDITION, PEARSON EDUCATION, 2007.

MODULE 1: PDE1 - 20 Hours

Partial Derivatives, Methods of solutions of dx/P=dy/Q=dz/R, Partial Differential Equations, Origins of first order partial differential equations.

Text Book 1-Chapter 1, Sections 3; Chapter 2 - Sections 1 & 2

MODULE 2: PDE2 - 25 Hours

Cauchy's problem for first order equations, Linear equations of first order

Text Book 1 – Chapter 2, Sections 3 & 4

MODULE 3: SPECIAL FUNCTIONS - 20 Hours

Legendre Functions, Gamma Function and Related Functions.

Text Book 2: Chapter 9- Sections 9.1 and 9.9.

MODULE 4: GROUP THEORY - 25 Hours

Groups, Subgroups, Cyclic groups, Groups of Permutations, Rings, Fields & Vector Spaces. (Definitions, examples and simple properties only)

Text Book 3 - Section 1.4, 1.5, 1.6, 2.8, 3.13, 4.18, 6.30

REFERENCES

1. 1 JOSEPH A GALLIAN: CONTEMPORARY ABSTRACT ALGEBRA, 7TH EDITION, BROOKS & COLE, 2010.
2. THOMAS AND FINNEY, CALCULUS AND ANALYTIC GEOMETRY, NINTH EDITION, PEARSON, 2002.
3. K F RILEY AND M P HOBSON, ESSENTIAL MATHEMATICAL METHODS FOR PHYSICAL SCIENCES, CAMBRIDGE UNIVERSITY PRESS, 2011.

Question Paper Pattern

The following guidelines shall be followed during question paper setting.

Module	Part A	Part B	Part C
I	4	3	1
II	2	2	1
III	2	2	1
IV	4	2	1
Total	**12**	**9**	**4**

COMPLEMENTARY COURSES IN MATHEMATICS FOR UNDERGRADUATE PROGRAMME IN CHEMISTRY

SEMESTER I

BDMC101: MATHEMATICS FOR CHEMISTRY - I

Total Hours: 72

Credit: 3

COURSE OBJECTIVE

- To impart knowledge about various mathematical tools employed to study physics problems.
- Better understanding of matrices and matrix algebra.
- To acquire basic knowledge of curve and surfaces.
- Understand the basic theory of differential and integral calculus.

COURSE OUTCOME

- Refine geometrical problem-solving and analysis skills and relate them to existing body of knowledge in mathematics, physics, and engineering.
- Use Gauss-Jordan elimination to solve systems of linear equations and to compute the inverse of an invertible matrix.
- Able to work with multivariable functions.

TEXT BOOKS

1. FRANK AYRES JR: MATRICES-SHAUMS' OUTLINE SERIES, TMH EDITION, 1962.
2. THOMAS AND FINNEY, CALCULUS AND ANALYTIC GEOMETRY, NINTH EDITION, PEARSON, 2002.
3. GEORGE B. THOMAS, JR: THOMAS' CALCULUS TWELFTH EDITION, PEARSON, 2016

MODULE 1: MATRICES - 20 Hours

Rank of a Matrix, Row Canonical form, Normal form, Elementary matrices, System of linear equations, Solution by Matrix Method, Cramers rule and elementary transformations, Characteristic equation of a matrix; Characteristic roots and characteristic vectors, Cayley-Hamilton theorem (statement only) and simple applications

Text Book 1- Chapters – 5, 10, 19, 23

MODULE 2: CURVES AND SURFACES - 15 Hours

Circle, Parabola, Ellipse, Hyperbola, Classifying Conic sections by eccentricity, Quadratic equations and rotations, Parameterization of Plane Curves, Cylinders and Quadric Surfaces, Cylindrical and Spherical coordinates.

Text Book 2 – Sections 9.1-9.8; 10.6-10.7

MODULE 3: DIFFERENTIAL CALCULUS & APPLICATIONS OF DERIVATIVES - 20 Hours

Derivative of a function, differentiation rules, the chain rule and parametric equations, implicit differentiation, Extreme values of functions, Functions of Several Variables, Partial Derivatives

Text Book 3-Sections 3.1 – 3.3; 3.6; 3.7; 4.1; 14.1, 14.3

MODULE 4: INTEGRAL CALCULUS - 17 Hours

Area between curves, Volumes by slicing and rotations about an axis (Disc Method only), Length of Plane Curves , Areas of Surfaces of Revolution, Double Integrals, Double Integrals in Polar Form, Triple Integrals in Rectangular Form)

Text Book 3- Sections 5.6; 6.1; 6.3; 6.5; 15.3

REFERENCES

1. ERWIN KREYSZIG: ADVANCED ENGINEERING MATHEMATICS – 8TH EDITION WILEY INDIA, 2007.
2. K F RILEY AND M P HOBSON: ESSENTIAL MATHEMATICAL METHODS FOR PHYSICAL SCIENCES, CAMBRIDGE UNIVERSITY PRESS, 2011.
3. MERLE C. POTTER: ADVANCED ENGINEERING MATHEMATICS, OXFORD UNIVERSITY PRESS, 2005.
4. DAVID W. LEWIS: MATRIX THEORY (ALLIED), 1991.

Question Paper Pattern

The following guidelines shall be followed during question paper setting

Module	Part A	Part B	Part C
I	4	3	1
II	3	3	1
III	3	2	1
IV	2	1	1
Total	**12**	**9**	**4**

SEMESTER II

BDMC202: MATHEMATICS FOR CHEMISTRY - II

Total Hours: 72

Credit: 3

COURSE OBJECTIVE

- The purpose of the course is to provide an understanding of the basic relations of vector analysis, to demonstrate practical applications of vector analysis and to train the student in problem formalization and in methods of solution.
- To give students an understanding of discrete Fourier series and integral Fourier and inverse-Fourier transforms, and provide students with practice in their application and interpretation in a range of situations.

COURSE OUTCOME

- Analyse the integral ideas of the functions defined including line, surface and volume integrals - both derivation and calculation in rectangular, cylindrical and spherical coordinate systems and understand the proofs of each instance of the fundamental theorem of calculus
- Find Fourier series and Fourier transform.

TEXT BOOKS

1. ERWIN KREYSZIG: ADVANCED ENGINEERING MATHEMATICS, EIGHTH EDITION, WILEY, INDIA, 2007.

MODULE 1: VECTOR DIFFERENTIAL CALCULUS - 22 Hours

Vector Algebra in 2-space and 3-space, Inner Product, Vector Product, Vector and Scalar Functions and Fields, Derivatives, Curves, Tangents, Arc Lengths, Gradient of a Scalar Field, Directional Derivative, Divergence of a Vector field, Curl of a vector field.

Text Book 1-Chapter 8, Sections 8.1-8.5, 8.9-8.11

MODULE 2: VECTOR INTEGRAL CALCULUS - 22 Hours

Line integrals, Line integrals, Independence of Path, Green's Theorem in the Plane (Theorem without Proof), Surfaces for Surface Integrals, Triple Integrals, Divergence Theorem of Gauss, Further Applications of Divergence Theorem, Stoke's Theorem (without proof).

Text Book 1 – Chapter 9, Sections 9.1-9.9.

MODULE 3: FOURIER SERIES - 15 Hours

Periodic Functions, Trigonometric Series, Functions of any period p = 2L Fourier series, Even and Odd functions, Half-range Expansions.

Text Book 1 -Sections 10.1, 10.2, 10.3, 10.4 of Text 2 – Excluding Proofs).

MODULE 4: FOURIER TRANFORMS - 13 Hours

Fourier integrals, Fourier cosine and sine transforms, Fourier transforms.

Text Book 1- Sections 10.8-10.10.

REFERENCES

1. GEORGE B. THOMAS, JR: THOMAS' CALCULUS TWELFTH EDITION, PEARSON, 2016
2. K F RILEY AND M P HOBSON, ESSENTIAL MATHEMATICAL METHODS FOR PHYSICAL SCIENCES, CAMBRIDGE UNIVERSITY PRESS, 2011.
2 P.P.G DYKE: AN INTRODUCTION TO LAPLACE TRANSFORMS AND FOURIER SERIES (SPRINGER 2005.

Question Paper Pattern.

The following guidelines shall be followed during question paper setting.

Module	Part A	Part B	Part C
I	4	2	2
II	3	3	1
III	2	2	1
IV	3	2	0
Total	**12**	**9**	**4**

SEMESTER III

BDMC303: MATHEMATICS FOR CHEMISTRY – III

Total Hours: 90

Credit: 4

COURSE OBJECTIVES

- To expose the students to the basic ideas of differential equations combined with some ideas from linear algebra.
- To provide students with the skills, knowledge and attitudes required to determine approximate numerical solutions to mathematical problems which cannot always be solved by conventional analytical techniques
- To demonstrate the importance of selecting the right numerical technique for a particular application, and carefully analysing and interpreting the results obtained.

COURSE OUTCOME

- Solve differential equations of first order using graphical, numerical, and analytical methods,
- Solve and apply linear differential equations of second order (and higher)
- Using appropriate numerical methods, determine approximate solutions to ordinary differential equations.
- Demonstrate the use of interpolation methods to find intermediate values in given graphical and/or tabulated data.

TEXT BOOKS

1. A. H SIDDIQI, P MANCHANADA: A FIRST COURSE IN DIFFERENTIAL EQUATIONS WITH APPLICATIONS, MACMILLAN INDIA LTD, 2006.
2. S.S. SASTRY: INTRODUCTORY METHODS OF NUMERICAL ANALYSIS, 4^{TH} EDITION (PRENTICE HALL, 2005.

MODULE 1: ODE I - 20 Hours

Exact Differential Equation, Linear Equations , Solutions by Substitutions, Equations of first order and not of first degree , First order equations of higher degree solvable for p, Equations solvable for y , Equations solvable for x, Equations of first degree in x and y, Lagrange's and Clairaut's Equations.

Text Book 1: Sections 2.1-2.4; 3.1- 3.5

MODULE 2: ODE II - 25 Hours

Homogenous Linear Equations with constant coefficients, Method of undetermined coefficients.

Numerical solutions to ordinary differential equations- Solution by Taylor series, Picard's method of successive approximations.

Text Book 1-Sections 5.5-5.6; 10.1-10.4

MODULE 3: NUMERICAL METHODS I - 20 Hours

Solutions of Numerical, Algebraic and Transcendental equations-The Bisection Method, Iteration Method, Regula Falsi method, Newton-Raphson method

Text Book 2-Sections 3.1-3.4

MODULE 4: NUMERICAL METHODS II - 25 Hours

Finite differences, Interpolation for equal intervals, Central difference, Interpolation formula, Numerical differentiation and integration.

Text Book 2- Sections 5.1-5.3; 6.1-6.3; 7.1-7.4; 9.1-9.3; 9.6-9.13

REFERENCES

1. R. K. GHOSH, K. C. MAITY: AN INTRODUCTION TO DIFFERENTIAL EQUATIONS, NEW CENTRAL BOOKS, 2010.
2. SHEPLEY L. ROSS: DIFFERENTIAL EQUATION, WILEY INDIA, 2007
3. SRIMANTA PAL: NUMERICAL METHODS, OXFORD UNIVERSITY PRESS, 2009.

Question Paper Pattern.

The following guidelines shall be followed during question paper setting.

Module	Part A	Part B	Part C
I	3	2	1
II	3	3	1
III	3	2	1
IV	3	2	1
Total	**12**	**9**	**4**

SEMESTER IV

BDMC404: MATHEMATICS FOR CHEMISTRY - IV

Total Hours: 90

Credit: 4

COURSE OBJECTIVES

- Partial differential equations allow deterministic mathematical formulations of phenomena in physics and engineering as well as biological processes among many other scenarios
- To present the main results in the context of partial differential equations that allow learning about these models and to study numerical methods for the approximation of their solution.
- To determine types of PDEs which may be solved by application of special functions.
- To study about the basic structures known as groups and the symmetry.

COURSE OUTCOME

- Be familiar with the modeling assumptions and derivations that lead to PDEs,
- Recognize the major classification of PDEs and the qualitative differences between the classes of equations
- Be competent in solving linear PDEs using classical solution methods.
- Verify group properties in particular examples.
- Recall and use the definitions and properties of cosets and subgroups.

TEXT BOOKS

1 KREYSZIG-ADVANCED ENGINEERING MATHEMATICS – 8TH EDITION WILEY INDIA, 2007.

2 IAN SNEDDON – ELEMENTS OF PARTIAL DIFFERENTIAL EQUATION (TATA MCGRAW HILL), 2004.

3 JOHN B FRALEIGH- A FIRST COURSE IN ABSTRACT ALGEBRA, 7TH EDITION, PEARSON EDUCATION, 2007.

4 F ALBERT COTTON - CHEMICAL APPLICATIONS OF GROUP THEORY, CAMBRIDGE, 2003.

MODULE 1: SPECIAL FUNCTIONS - 25 Hours

Power series method of solving differential equations. Legendre equation and Legendre Polynomials, Rodrigues Formula, Bessel's Equation and Bessel Functions

Text Book 1-Sections 2.1, 2.2, 2.3, 2.4, 2.5, 2.11

MODULE 2: PDE - 20 Hours

Solution of equations of the form, Integral curves of equations, Origin of first order partial differential equations, Linear equations of the first order- Lagrange's equations

Text Book 2- Chapter 1: Sections 1 and 3; Chapter 2: Sections 1, 2, 4

MODULE 3: GROUP THEORY I - 15 Hours

Groups, Subgroups, Cyclic groups, Groups of Permutations, Rings, Fields & Vector Spaces. (Definitions, examples and simple properties only)

Text Book 3 - Section 1.4, 1.5, 1.6, 2.8, 3.13, 4.18, 6.30

MODULE 4: GROUP THEORY II - 30 Hours

Symmetry Elements and operations, Symmetry planes and reflections, The inversion center, Proper axes and proper rotations, Improper axes and improper rotations, Products of symmetry operations, Equivalent symmetry elements, Symmetry elements, The Symmetry point groups.

Text Book 4-Sections 3.2-3.11

Question Paper Pattern.

The following guidelines shall be followed during question paper setting.

Module	Part A	Part B	Part C
I	3	3	2
II	3	2	1
III	4	2	1
IV	2	2	0
Total	**12**	**9**	**4**

COMPLEMENTARY COURSES IN MATHEMATICS FOR UNDERGRADUATE PROGRAMME IN COMPUTER APPLICATIONS

SEMESTER I

BDMA101: DISCRETE MATHEMATICS - I

Total Hours: 72

Credit: 3

COURSE OBJECTIVE

- To gain a better understanding of what happens in the course of a proof and a systematic language or framework within which to develop the ideas involved.
- To understand Propositional calculus more clearly
- Better understanding of matrices

COURSE OUTCOME

- Demonstrate accurate and efficient use of logical and set theoretical techniques.
- Able to write and understand proofs as formal logical process.
- Solve systems of linear equations.

TEXT BOOKS:

4. KENNETH H ROSEN, DISCRETE MATHEMATICS AND ITS APPLICATIONS, SIXTH EDITION, 2009.
5. FRANK AYRES JR, MATRICES, SCHAUM'S OUTLINE SERIES, TMH EDITION, 1974.

MODULE 1: LOGIC I - 18 Hours

Propositional logic, propositional equivalences, predicates and quantifiers, nested quantifiers.

Text Book 1 - Sections 1.1, 1.2, 1.3, 1.4

MODULE 2: LOGIC II - 18 Hours

Rules of inference, introduction to proofs, proof methods and strategy.

Text Book 1 -Sections 1.5, 1.6, 1.7

MODULE 3: BASIC STRUCTURES - 18 Hours

A quick review of set theory, functions, sequences and summations, relations and their properties, n-ary relations and their applications, representing relations, closures of relations, equivalence relations, partial orderings.

Text Book 1 - Chapter 2, 7

MODULE 4: MATRICES - 18 Hours

A quick review of the fundamental concepts, rank of a matrix, non-singular and singular matrices, elementary transformations, inverse of a non-singular matrix, canonical form, normal form, systems of linear equations: homogenous and non-homogenous equations, characteristic equation of a matrix. (Proof of all theorems are to be excluded.)
(Relevant sections of Text Book 2)

REFERENCES

1. D L JOHNSON, ELEMENTS OF LOGIC VIA NUMBERS AND SETS, SPRINGER, 1998.
2. THOMAS AND FINNEY, CALCULUS AND ANALYTIC GEOMETRY, NINTH EDITION, PEARSON, 1995

Question Paper Pattern

The following guidelines shall be followed during question paper setting.

Module	Part A	Part B	Part C
I	3	3	1
II	3	2	1
III	3	2	1
IV	3	2	1
Total	**12**	**9**	**4**

SEMESTER II

BDMA202: DISCRETE MATHEMATICS - II

Total Hours: 72

Credit: 3

COURSE OBJECTIVE

- To define how graphs serve as models for many standard problems.
- To discuss the concepts of graphs, trees, Eulerian graphs, combinatorics and Boolean algebra.

COURSE OUTCOME

- Define and relate basic notions in graph theory. To apply algorithms and theorems in graph theory in solving real life problems such job assignment, colouring etc
- Describe and solve real world problems using concepts of combinatorics.

TEXT BOOKS:

1. KENNETH H ROSEN, DISCRETE MATHEMATICS AND ITS APPLICATIONS, SIXTH EDITION, 2009.

MODULE 1: COMBINATORICS - 18 Hours

The basics of counting, the pigeonhole principle, permutations and combinations, binomial coefficients, generalized permutations and combinations, generating permutations and combinations.

Text Book 1- Chapter 5

MODULE 2: GRAPH THEORY I - 18 Hours

Graphs and graph models, graph terminology and special types of graphs, representing graphs and graph isomorphism, connectivity, Euler and Hamiltonian paths, Shortest path problems, planar graphs, graph coloring

Text Book 1- Chapter 8

MODULE 3: GRAPH THEORY II - 18 Hours

Introduction to trees, applications of trees, tree traversal, spanning trees, minimum spanning trees.

Text Book 1- Chapter 9

MODULE 4: BOOLEAN ALGEBRA - 18 Hours

Boolean functions, representing Boolean functions, logic gates, minimization of circuits

Text Book 1- Chapter 10

REFERENCES

1. JOHN CLARK & DEREK ALLEN HOLTEN: A FIRST LOOK AT GRAPH THEORY-ALLIED PUBLISHERS, 1991.
2. C.L LIU-ELEMENTS OF DISCRETE MATHEMATICS, MC GRAW –HILL, 2012
3. CHEN CHUAN CHONG, KOH KHEE MENG, PRINCIPLES AND TECHNIQUES IN COMBINATORICS (WORLD SCIENTIFIC), 1992

Question Paper Pattern

The following guidelines shall be followed during question paper setting

Module	Part A	Part B	Part C
I	3	3	2
II	3	2	1
III	4	2	1
IV	2	2	0
Total	**12**	**9**	**4**

COMPLEMENTARY COURSES IN STATISTICS FOR UNDERGRADUATE PROGRAMME IN MATHEMATICS

SEMESTER I

BDSM101: BASIC STATISTICS

Total Hours: 72

Credit: 3

COURSE OBJECTIVE

- To collect, organise, and represent data, and be able to recognise and describe relationships.
- To create, read, and interpret graphs, charts, histograms, and diagrams.
- To understand and use the basic measure of central tendency.
- To measure relative or percentage changes in the variable over time.
- To ascertain the living standards of people using index numbers.

COURSE OUTCOMES

- Demonstrate the ability to apply fundamental concepts in exploratory data analysis.
- Distinguish between different types of data.
- Interpret examples of methods for summarising data sets, including common graphical tools (such as box plots, histograms and stem plots) and summary statistics (such as mean, median, mode, variance and IQR).
- Assess which methods for summarising a data set are most appropriate to highlight interesting features of the data.

TEXT BOOK

1. S.C. GUPTA AND V.K. KAPOOR: FUNDAMENTALS OF MATHEMATICAL STATISTICS, SULTAN CHAND AND SONS, 1997.

MODULE 1: INTRODUCTION TO STATISTICS - 12 Hours

Introduction to Statistics – Definitions, Uses and applications of statistics, Misuse of statistics. Definition of Population and Sample, Census and Sampling, primary and secondary data. Methods of collecting primary data, Methods of Sampling (Definitions only) - Simple Random Sampling (with and without replacement), stratified sampling, systematic sampling. Types of data – quantitative and qualitative data, Levels of measurement – nominal, ordinal, interval and ratio scales, Classification and Tabulation, Diagrammatic representation - Bar diagrams, pie diagram Graphical representation -histogram; frequency polygon; frequency curve; ogives and stem and leaf chart.

MODULE 2: MEASURES OF CENTRAL TENDENCY AND DISPERSION - 30 Hours

Measures of Central Tendency - Mean; Median; Mode; Geometric Mean; Harmonic Mean and Properties. Absolute and Relative measures of Dispersion - Range, Quartile Deviation, Percentiles, Deciles, Box Plot, Mean Deviation, Standard Deviation, Coefficient of Variation.

MODULE 3: MOMENTS AND KURTOSIS - 18 Hours

Moments - Raw and Central Moments, Absolute Moments, Inter Relationships (First Four Moments. Skewness – Types of Skewness, Measures - Pearson, Bowley and Moment Measure .Kurtosis- Types of Kurtosis, Measures of Kurtosis - Measure based on moments

MODULE 4: INDEX NUMBERS - 12 Hours

Index Numbers - definition, uses, types of index numbers – simple and weighted indices, Simple Index Numbers- AM, GM and HM indices and aggregate index number, Weighted Index Numbers – Laspeyer's, Paasche's and Fisher's Index Numbers. Test of Index Numbers and Construction of Index Numbers, Cost of Living Index Numbers - Family Budget Method, Aggregate Expenditure Method.

REFERENCES

1. S.P. GUPTA: STATISTICAL METHODS (SULTAN CHAND & SONS DELHI), 1982.
2. B.L. AGARWAL: BASIC STATISTICS, NEW AGE INTERNATIONAL (P) LTD, 2006.

Question Paper Pattern.

The following guidelines shall be followed during question paper setting.

Module	Part A	Part B	Part C
I	3	2	1
II	3	3	1
III	3	2	1
IV	3	2	1
Total	**12**	**9**	**4**

SEMESTER II

BDSM202: THEORY OF PROBABILITY AND RANDOM VARIABLES

Total Hours: 72

Credit: 3

COURSE OBJECTIVES

- To provide an understanding of the statistical concepts like probability, probability distributions, regression, and correlation analysis, multiple regression and business/economic forecasting
- To apply discrete and continuous probability distributions to various business problems.
- To understand the definitions of and notations for random variables, events associated to a random variable, probabilities of events, and how these relate.

COURSE OUTCOMES

- Demonstrate an understanding of the basic concepts of probability and random variables.
- Describe the sample space for certain random experiments
- Explain probability in terms of long-term relative frequencies in repetitions of experiment
- Describe the main properties of probability distributions and random variables.
- Identify the random variable(s) of interest in a given scenario.
- Study two or more variables simultaneously and able to find the quantitative relationship between them.

TEXT BOOK

1. S.C. GUPTA AND V.K. KAPOOR: FUNDAMENTALS OF MATHEMATICAL STATISTICS, SULTAN CHAND AND SONS, 1997.

MODULE 1: PROBABILITY - 16 Hours

Probability Concepts, Random Experiment, Sample Space, Events – Mutually exclusive, exhaustive, equally likely events. Approaches to Probability- Classical, Statistical and Axiomatic. Addition Theorem of probability for two, three and n events (with proof), Boole's

inequality. Conditional Probability, Independence of events, Multiplication theorem (upto 3 events).Total Probability Law, Baye's Theorem.

MODULE 2: RANDOM VARIABLES AND PROBABILITY DISTRIBUTIONS - 18 Hours

Random Variables - Discrete and Continuous, Probability Distributions.

Probability Mass Function; Probability Density Function and Cumulative (distribution) function and their properties. Change of variables (Univariate only)

MODULE 3: BIVARIATE RANDOM VARIABLES - 16 Hours

Bivariate random variables - Definition of Discrete and Continuous cases.

Joint Probability Density Functions, Marginal and Conditional Distributions, Independence of Random Variables.

MODULE 4: CORRELATION AND REGRESSION - 22 Hours

Bivariate data, Method of Least Squares for fitting a curve and normal equations.

Fitting of Straight Lines, Second Degree Equation, Exponential Curve, Power Curve.

Linear Correlation, Methods of Correlation, Scatter Diagram, Covariance Method, Rank Correlation (with equal ranks).

Linear Regression - Regression Equations, Fitting and identification, properties.

REFERENCES

1. S.P. GUPTA: STATISTICAL METHODS, , SULTAN CHAND AND SONS, NEW DELHI,1982.
2. B.L. AGARWAL: BASIC STATISTICS, NEW AGE INTERNATIONAL (P) LTD,2006.

Question Paper Pattern.

The following guidelines shall be followed during question paper setting.

Module	Part A	Part B	Part C
I	3	2	1
II	3	3	0
III	3	2	1
IV	3	2	2
Total	**12**	**9**	**4**

SEMESTER III

BDSM303: PROBABILITY DISTRIBUTIONS

Total Hours: 90

Credit: 4

COURSE OBJECTIVES

- Demonstrate knowledge of probability and the standard statistical distributions.
- Calculate the mean and variance of a discrete random variable.
- Apply general properties of the expectation and variance operators.

COURSE OUTCOMES

- To apply discrete and continuous probability distributions to various business problems.
- Interpret the mean of a random variable in terms of the Law of Large Numbers.

TEXT BOOK

1. S.C. GUPTA AND V.K. KAPOOR: FUNDAMENTALS OF MATHEMATICAL STATISTICS, SULTAN CHAND AND SONS, 1997.

MODULE 1: MATHEMATICAL EXPECTATIONS - 22 hours

Mathematical Expectations - Expectation of a Random Variable, Moments in terms of Expectations, Moment Generating Functions (m.g.f.) and its properties. Characteristic Functions and its Simple Properties, Conditional Expectation

MODULE II: DISCRETE DISTRIBUTIONS - 30 hours

Discrete Distributions – Uniform, Bernoulli; Binomial. Poisson, Geometric distributions. Mean, Variance, moment generating function. Additive property and Fitting of Distributions (Binomial and Poisson only). Recurrence relation for moments of binomial and Poisson distributions. Mode of Binomial and Poisson distributions. Poisson distribution as a limiting form of Binomial distribution. Lack of Memory property of Geometric distribution (with proof)

MODULE 3: CONTINUOUS DISTRIBUTIONS - 20 Hours

Continuous distributions – Definition, Mean, variance and M G F of Uniform; Exponential; Gamma; Beta (type I and II) distributions. Lack Memory property of exponential distribution Normal; Standard Normal - definitions, Mean, Variance, m.g.f., Additive property, Fitting of Normal, Use of Standard Normal Tables for Computation of Various Probabilities. Normal distribution as a limiting form of Binomial and Poisson distributions.

MODULE 4: LAW OF LARGE NUMBERS - 18 Hours

Law of large Numbers, Tchebycheff's Inequality, Weak Law of Large Numbers, Bernoulli's Law of Large Numbers, Central Limit Theorem (Lindberg-Levy form) without proof.

REFERENCE

1. HOGG, R.V. AND CRAIG A.T - (1970). INTRODUCTION TO MATHEMATICAL STATISTICS, AMERIND PUBLISHING CO, PVT, 1970.
2. V.K. ROHATGI: AN INTRODUCTION TO PROBABILITY THEORY AND MATHEMATICAL STATISTICS, WILEY EASTERN, 1976.
3. MOOD A.M., GRAYBILL F.A. AND BOES D.C. INTRODUCTION TO THEORY OF STATISTICS, MCGRAW HILL, 1973.

Question Paper Pattern.

The following guidelines shall be followed during question paper setting.

Module	Part A	Part B	Part C
I	2	2	0
II	4	2	2
III	4	3	2
IV	2	2	0
Total	**12**	**9**	**4**

SEMESTER IV

BDSM404: STATISTICAL INFERENCE

Total Hours: 90

Credit: 4

COURSE OBJECTIVES

- Understand the concepts of hypothesis testing.
- Learn how to set up hypotheses.

  Learn how to perform hypothesis testing for population proportion by the *p*-value approach.
- Perform statistical test for population mean.
- Use confidence interval to draw conclusion about two-sided test.
- Learn how to calculate power and to choose the sample size for testing the population mean.

COURSE OUTCOMES

- Basic theoretical knowledge about fundamental principles for statistical inference.
- Perform point estimation, hypothesis testing and interval estimation under a large variety of discrete and continuous probability models.
- Evaluate the properties of these estimators and tests, for both finite sample sizes and asymptotically as the sample size tends to infinity.

TEXT BOOK

1. S.C. GUPTA AND V.K. KAPOOR: FUNDAMENTALS OF MATHEMATICAL STATISTICS, SULTAN CHAND AND SONS, 1997.

MODULE 1: SAMPLING DISTRIBUTIONS - 20 hours

Sampling Distributions - definition of Statistic, Parameter, Standard Error.

Sampling Distributions of Mean and Variance (σ^2)

t and F distributions (without derivation), properties, Inter relationships.

Statistics following χ^2, t and F distributions

MODULE 2: THEORY OF ESTIMATION - 25 Hours

Concepts of Estimation, Types of Estimation - Point Estimation; Interval Estimation.

Properties of Estimates - Unbiasedness, Efficiency; Consistency; Sufficiency.

Methods of Estimation MLE, Methods of Moments, Method of Minimum Variance, Cramer-Rao Inequality (without proof).

Interval Estimation for Mean, Variance and Proportion.

MODULE 3: TESTING OF HYPOTHESIS - 25 Hours

Testing of hypothesis- Statistical hypothesis, Simple and composite hypothesis, Null and Alternate hypothesis, Type I and Type II errors, Critical Region, Size of the test, P value, Power, Neyman Pearson approach.

MODULE 4: LARGE AND SMALL SAMPLE TESTS - 20 hours

Large Sample tests - Z test, Chi-Square test-goodness of fit, test of independence.

Small sample tests - Normal, t test, Chi-square test, F test.

REFERENCE

1. 1S.C GUPTA: FUNDAMENTALS OF MATHEMATICAL STATISTICS, SULTAN CHAND AND SONS, 1982.
2. 2V.K. ROHATGI: AN INTRODUCTION TO PROBABILITY THEORY AND MATHEMATICAL STATISTICS, WILEY EASTERN, 1976.
3. 3MOOD A.M., GRAYBILL F.A. AND BOES D.C. INTRODUCTION TO THEORY OF STATISTICS, MCGRAW HILL, 1973.

Question Paper Pattern.

The following guidelines shall be followed during question paper setting

Module	Part A	Part B	Part C
I	3	2	0
II	4	3	1
III	3	2	1
IV	2	2	2
Total	**12**	**9**	**4**

COMPLEMENTARY COURSES IN STATISTICS FOR UNDERGRADUATE PROGRAMME IN COMPUTER APPLICATIONS

SEMESTER I

BDSC101: INTRODUCTORY STATISTICS

Total Hours: 72

Credit: 3

COURSE OBJECTIVE

- To collect, organise, and represent data, and be able to recognise and describe relationships.
- To create, read, and interpret graphs, charts, histograms, and diagrams.
- To understand and use the basic measure of central tendency.
- To apply discrete and continuous probability distributions to various business problems.
- To understand the definitions of and notations for random variables, events associated to a random variable, probabilities of events, and how these relate.

COURSE OUTCOMES

- Demonstrate the ability to apply fundamental concepts in exploratory data analysis.
- Distinguish between different types of data.
- Interpret examples of methods for summarising data sets, including common graphical tools (such as box plots, histograms and stem plots) and summary statistics (such as mean, median, mode, variance and IQR).
- Demonstrate an understanding of the basic concepts of probability and random variables.
- Describe the sample space for certain random experiments

TEXT BOOK

1. S.C. GUPTA AND V.K. KAPOOR: FUNDAMENTALS OF MATHEMATICAL STATISTICS, SULTAN CHAND AND SONS, 1997.

MODULE 1: INTRODUCTION TO STATISTICS - 14 Hours

Introduction to Statistics – Definitions, Uses and applications of statistics, Misuse of statistics. Definition of Population and Sample, Census and Sampling, primary and secondary data.

Methods of collecting primary data, Methods of Sampling (Definitions only) - Simple Random Sampling (with and without replacement) , stratified sampling , systematic sampling, Types of data – quantitative and qualitative data, Levels of measurement – nominal, ordinal, interval and ratio scales , Classification and Tabulation, Diagrammatic representation - Bar diagrams, pie diagram Graphical representation -histogram; frequency polygon; frequency curve; ogives and stem and leaf chart.

MODULE 2: MEASURES OF CENTRAL TENDENCY - 18 Hours

Measures of Central Tendency - Mean; Median; Mode; Geometric Mean; Harmonic Mean and Properties. Absolute and Relative measures of Dispersion - Range, Quartile Deviation, Percentiles, Deciles, Box Plot, Mean Deviation, Standard Deviation, Coefficient of Variation.

MODULE 3: PROBABILITY – 20 Hours

Probability Concepts, Random Experiment, Sample Space, Events – Mutually exclusive, exhaustive, equally likely events. Approaches to Probability- Classical, Statistical and Axiomatic. Addition Theorem of probability for two, three and n events (with proof), Boole's inequality. Conditional Probability, Independence of events, Multiplication heorem (upto 3 events). Total Probability Law, Baye's Theorem.

MODULE 4: RANDOM VARIABLES AND MATHEMATICAL EXPECTATIONS – 20 Hours

Random Variables - Discrete and Continuous, Probability Distributions.

Probability Mass Function of discrete and Probability Density Function of continuous Random variables, and Cumulative (distribution) function and their properties.

Mathematical Expectations - Expectation of a Random Variable, Moments in terms of Expectations, Moment Generating Functions (m.g.f.) and its properties.

REFERENCES

1. S.P. GUPTA: STATISTICAL METHODS (SULTAN CHAND & SONS DELHI), 1982
2. B.L. AGARWAL: BASIC STATISTICS, NEW AGE INTERNATIONAL (P) LTD, 2006.

Question Paper Pattern.

The following guidelines shall be followed during question paper setting.

Module	Part A	Part B	Part C
I	3	2	1
II	3	3	2
III	3	2	1
IV	3	2	0
Total	**12**	**9**	**4**

SEMESTER III

BDSC302: ADVANCED STATISTICS

Total Hours: 72

Credit: 4

COURSE OBJECTIVE

- To provide an understanding of the statistical concepts like probability, probability distributions, regression, and correlation analysis, multiple regression and business/economic forecasting
- To apply discrete and continuous probability distributions to various business problems.
- Apply general properties of the expectation and variance operators
- To have basic theoretical knowledge about fundamental principles for statistical inference

COURSE OUTCOMES

- Study two or more variables simultaneously and able to find the quantitative relationship between them.
- To apply discrete and continuous probability distributions to various business problems
- Perform point estimation and interval estimation under a large variety of discrete and continuous probability models.

TEXT BOOK

1. S.C. GUPTA AND V.K. KAPOOR: FUNDAMENTALS OF MATHEMATICAL STATISTICS, SULTAN CHAND AND SONS, 1997.

MODULE 1: CORRELATION AND REGRESSION - 14 Hours

Bivariate data, Method of Least Squares for fitting a curve and normal equations.

Fitting of Straight Lines, Second Degree Equation, Exponential Curve, Power Curve.

Linear Correlation, Methods of Correlation, Scatter Diagram, Covariance Method, Rank Correlation (with equal ranks).

Linear Regression - Regression Equations, Fitting and identification, properties.

MODULE 2: DISCRETE AND CONTINUOUS DISTRIBUTIONS - 22 Hours

Discrete Distributions – Binomial. Poisson, Geometric distributions.

Mean, Variance, moment generating function. Additive property and Fitting of Distributions (Binomial and Poisson only). Recurrence relation for moments of binomial and Poisson distributions. Mode of Binomial and Poisson distributions. Poisson distribution as a limiting form of Binomial distribution. Lack of Memory property of Geometric distribution (with proof)

Continuous distribution – Definition, Mean, variance and M G F of Normal; Standard Normal - definitions, Mean, Variance, m.g.f., Additive property, Fitting of Normal, Use of Standard Normal Tables for Computation of Various Probabilities.

MODULE 3: SAMPLING DISTRIBUTIONS - 16 Hours

Sampling Distributions - definition of Statistic, Parameter, Standard Error. Sampling Distributions of Mean and Variance. σ^2, t and F distributions (without derivation), properties, Inter relationships. Statistics following χ^2, t and F distributions

MODULE 4: THEORY OF ESTIMATION- 20 Hours

Concepts of Estimation, Types of Estimation - Point Estimation; Interval Estimation. Properties of Estimates - Unbiasedness, Efficiency; Consistency; Sufficiency. Interval Estimation for Mean, Variance and Proportion.

Testing of hypothesis- Statistical hypothesis, Simple and composite hypothesis, Null and Alternate hypothesis, Type I and Type II errors, Critical Region, Size of the test, P value, Power, Neyman Pearson approach. Large Sample tests - Z test, Chi-Square test-goodness of fit, test of independence. Small sample tests - Normal, t test, Chi-square test, F test.

REFERENCES

1. S.C GUPTA: FUNDAMENTALS OF MATHEMATICAL STATISTICS, SULTAN CHAND & SONS, 1982.
2. V.K. ROHATGI: AN INTRODUCTION TO PROBABILITY THEORY AND MATHEMATICAL STATISTICS, WILEY EASTERN, 1976.
3. MOOD A.M., GRAYBILL F.A. AND BOES D.C. INTRODUCTION TO THEORY OF STATISTICS, MCGRAW HILL, 1973.

Question Paper Pattern.

The following guidelines shall be followed during question paper setting.

Module	Part A	Part B	Part C
I	3	2	1
II	3	2	1
III	3	2	0
IV	3	3	2
Total	**12**	**9**	**4**

SEMESTER IV

BDSC403: OPTIMIZATION TECHNIQUES

Total Hours: 72

Credit: 4

COURSE OBJECTIVES

- To understand the theory of optimization methods and algorithms developed for solving various types of linear programming problems.
- Game Theory is to make possible the analysis of the decision making process of interdependent subject

COURSE OUTCOME

- Able to formulate optimization problems. Achieve knowledge about techniques that can be used to solve such problems.
- Identify strategic situations and represent them as games
- Solve simple games using various techniques

TEXT BOOK

1. S. C. GUPTA AND V. K. KAPOOR, FUNDAMENTALS OF MATHEMATICAL STATISTICS SULTAN CHAND AND SONS, 1997.

MODULE 1: INTRODUCTION TO OPERATIONS RESEARCH – 14 Hours

Stochastic and deterministic models, Basics of operations research, the nature and uses of OR - Main concepts and approaches of OR-models in OR-Advantages of a model phases of OR.

MODULE 2: LINEAR PROGRAMMING PROBLEMS – 22 Hours

Linear programming problems; Mathematical formulation of a L.P.P General linear programming problems, solution of a L.P.P, graphical method for solving a L.P.P. Simplex Method: slack and surplus variables- reduction of any feasible solution to a basic feasible solution, dual problems, artificial variable techniques-Big M method. Duality in liner programming, Properties of duality, Formulation of Dual from
Primal.

MODULE 3: TRANSPORTATION AND ASSIGNMENT PROBLEMS – 16 Hours

Transportation problems: transportation model – Mathematical formulation, Solution by North West corner method, lowest cost entry method, Vogel's and MODI method Degeneracy and its solution.

Assignment problems. Assignment model, mathematical formulation, Solution of assignment problem for maximization and minimization of objective.

MODULE 4: INTRODUCTION TO GAME THEORY– 20 Hours

Two person Zero sum game, pure and mixed strategy with saddle point, Solution of pure strategy games, solution of mixed strategy games, Problems by arithmetic method, Principle of dominance, Solution by graphical method.

REFERENCES

1. SHELDON M. ROSS, STOCHASTIC PROCESSES, WILEY, 1996.
2. KANTI SWAROOP, OPERATIONS RESEARCH, 1965.

Question Paper Pattern.

The following guidelines shall be followed during question paper setting.

Module	Part A	Part B	Part C
I	2	1	0
II	4	3	1
III	3	3	2
IV	3	2	1
Total	**12**	**9**	**4**

OPEN COURSES

BOMM501: MATHEMATICAL MODELLING

Total Hours: 54

Credit: 3

COURSE OBJECTIVE

- Introduce mathematical models its classification and characteristics.
- Provide students with the knowledge of modeling dynamics and modeling of geometric problems.
- Introduction and examples of simulation

COURSE OUTCOME

- Apply analytical techniques to solve a mathematical model

TEXT BOOKS

1. MATHEMATICAL MODELLING- J.N.KAPOOR, NEW AGE INTERNATIONAL, 2001 REPRINT.
2. SYSTEM SIMULATION WITH DIGITAL COMPUTER- NARSINGDEO, PRENTICE HALL OF INDIA, SIXTH PRINTING, 1996.

MODULE 1: INTRODUCTION – 12 Hours

Mathematical modelling-what and why? Classification of mathematical models, Characteristics of mathematical models, Mathematical modelling through geometry, algebra, trigonometry & calculus, Limitations of mathematical modelling.

Text Book 1 -Chapter-1: Sections 1.1 - 1.9

MODULE 2: MODELLING THROUGH FIRST ORDER -14 Hours

Linear growth and decay models, Non-linear growth and decay models, Compartment models, Modelling in dynamics and Modelling of geometrical problems.

Text Book 1 - Chapter 2- Sections 2.1 - 2.6

MODULE 3: SYSTEM SIMULATION – 14 hours

Introduction, Examples, Nature of simulation, Simulation of a chemical reactor, Euler and Runge-Kutta integration formulae, Simulation of a water reservoir system, Simulation of a servo system. (Write and execute all the computer programs throughout this course using C)

Text Book 2 -Chapter 1- Sections 1.1 - 1.7 & Chapter 2- Sections 2.1 - 2.6 and 2.9

MODULE 4: DISCRETE SYSTEM SIMULATION – 14 Hours

Fixed time-step vs. event-to-event model, on simulating randomness, Monte-Carlo computation vs. stochastic simulation, Rudiments of queuing theory, Simulation of a single-server queue.

Text Book 2 - Chapter 3: Sections 3.1 - 3.7 and Chapter 4: Sections 4.1 & 4.2

REFERENCES

1. SYSTEM SIMULATION – GEOFFREY GORDON, PRENTICE HALL OF INDIA, SECOND EDITION, 2010.
2. MATHEMATICAL MODELING FOR INDUSTRY AND ENGINEERING-THOMAS SVOBODNY, PRENTICE HALL, 1988.

BOMM502: APPLICABLE MATHEMATICS

Total Hours: 54

Credit: 3

COURSE OBJECTIVE

- Able to apply quantitative reasoning and mathematical analysis methodologies to understand and solve problems.
- Students should be able to comprehend, work with, and apply general mathematical techniques and models to different situations, not just plug problem-specific data into a given formula.

COURSE OUTCOME

- These skills will enable students to effectively use and interpret data, formulas, and graphs in the workplace, in the news media, and when making personal finance, health, and other types of decisions as informed citizens.
- Apply general mathematical models to solve a variety of problems
- Apply mathematical language and notation to explain the reasoning underlying their conclusions when solving problems using mathematical or statistical techniques.

MODULE 1: NUMBER SYSTEM AND TRIGONOMETRY – 12 Hours

Types of numbers, Quadratic equations (Solution of quadratic equations with real roots only), Logarithms – All rules without proof, Multiplication and division of numbers, Evaluating expressions of the form $x^{p/q}$, x any real number, p & q are integers, Permutations and combinations – simple applications, Trigonometry introduction, Values of trigonometric ratios of 0^0, 30^0, 45^0, 60^0 & 90^0, Heights and distances – Simple cases - (application of sinx, cosx, tanx, and their reciprocals only). Two dimensional geometry- Introduction, plotting points and drawing graph of the lines of the form ax + by + c = 0.

MODULE 2: PROBABILITY AND REASONING - 14 Hours

Probability – Introduction – Sample spaces and events, Simple examples like tossing coin, tossing die etc.., Logical Reasoning- Number series, Letter series, Distance and directions, Odd man out, Number puzzles, Blood relations, Logical and analytical reasoning.

No core text book is needed for Modules 1 & 2

MODULE 3: RATIO, PROPORTION AND AVERAGE– 14 Hours

HCF and LCM of numbers, Fractions, Squares and square roots, cube and cube roots, simplifications, Ratio and Proportion, Percentage, Profit and loss, Simple average (No Weighed average)

(Sections – 2, 3, 5, 6, 7, 9, 10, 11, 13)

MODULE 4: ELEMENTARY MATHEMATICAL TECHNIQUES- 14 Hours

Simple interest, Compound interest, Time and work, Work and wages, (Exclude Pipes and Systems from the core reference), Time and distance, Elementary mensuration – Area and perimeter of polygons, Elementary Algebra, (Simplifications of algebraic expressions)

(Sections - 14, 15, 17, 18, 21, 22, 23)

CORE REFERENCE

1. M. TYRA, & K. KUNDAN : CONCEPTS OF ARITHMETIC, BSC PUBLISHING COMPANY PVT.LTD.C – 37, GANESH NAGAR, PANDAV NAGAR COMPLEX, DELHI, 2011.

BOMM503: FINANCIAL MATHEMATICS

Total Hours: 54

Credit: 3

COURSE OBJECTIVE

- Introduction to the theory of interest rates
- Comparison of value and yield of cash flow transactions.
- Understand valuation of fixed interest securities, with and without tax on interest and capital gains

COURSE OUTCOME

- Define and describe in detail the use of cash flow models, simple and compound rates of interest and discount as well as compare and distinguish between nominal and effective rates of interest and discount.
- Describe in detail the various types of annuities and perpetuities and use them to solve financial transaction problems.

TEXT BOOK:

1. MC CUTCH EON AND SCOT HEINEMANN, AN INTRODUCTION TO THE MATHEMATICS OF FINANCE, PROFESSIONAL PUBLISHING

MODULE 1: INTRODUCTION TO THEORY OF INTEREST RATES-14 Hours

Theory of interest rates: Rate of interest – Accumulation factors – Force of interest and Stoodley's formula for the force of interest. Basic Compound interest relations: Relationships between s, i, v, and d – The equation of value and yield on a transaction.

Annuity certain: Present values and accumulations – Loan schedule for a level annuity – Continuously payable annuities and varying (increasing and decreasing) annuities.

Nominal rates of interest: Annuities payable p –thly- present values and accumulations- Loan schedule for p-thly annuities.

MODULE 2: DISCOUNTED CASH FLOW– 16 Hours

Discounted cash flow: Net percent values and yields – The comparison two investment projects – The effects of inflation – The yield on a fund and measurement of investment performance. Capital Redemption Policies: Premium calculations- Policy values, Surrnder values, paid-up policy values and policy alterations, Stoodley's logistic model for the force of interest, reinvestment rates.

MODULE 3: VALUATION OF SECURITIES – 16 Hours

Valuation of securities: Fixed interest securities – Ordinary shares, prices and yields, perpetuities – Mak ham's formula, optional redemption dates – Effect of the term to redemption on the yield – Real returns and index linked stocks. Capital Gains Tax: Valuing a loan with allowance for capital gains tax - capital tax when the redemption price of the rate of tax is not constant - Finding the yield when there is capital gains tax - optional redemption dates – Offsetting capital losses against capital gains.

MODULE 4: CUMULATIVE SINKING FUNDS- 8 Hours

Cumulative Sinking Funds (Restricted coverage): The relationships between successive capital repayments – the term of the loan when the redemption price is constant.

REFERENCES

1. SHELDON M.ROSS - AN INTRODUCTION TO MATHEMATICAL FINANCE, CAMBRIDGE UNIVERSITY PRESS.
3. JOHN C. HULL - OPTIONS, FUTURES, AND OTHER DERIVATIVES, PRENTICE HALL OF INDIA PVT LTD.
4. SALIH N. NEFTCI -AN INTRODUCTION TO THE MATHEMATICS OF FINANCIAL DERIVATIVES, ACADEMIC PRESS.
5. ROBERT J ELLIOT AND P EKKEHARD KOPP - MATHEMATICS OF FINANCIAL MARKET, SPRINGER- VERLAG, NEW YORK INC.

BOMM504: MATHEMATICAL ECONOMICS

Total Hours: 54

Credit: 3

COURSE OBJECTIVE

- Focuses on the mathematical methods and models that are required to understand current economics and to investigate economic models.
- Provides students with fundamental mathematical skills that are essential for the study and practice of economics.
- Understand valuation of fixed interest securities, with and without tax on interest and capital gains

COURSE OUTCOME

- Model economic questions as mathematical problems.

TEXT BOOKS:

1. H.L. AHUJA: PRINCIPLES OF MICROECONOMICS, 15TH REVISED EDITION, S. CHAND
2. EDWARD T. DOWLING: INTRODUCTION TO MATHEMATICAL ECONOMICS, SCHAUM'S OUTLINE SERIES, THIRD EDITION, TMH.

MODULE 1: DEMAND AND SUPPLY ANALYSIS - 14 Hours

Utility and demand – the meaning of demand and quantity demanded – the law of demand – demand curve – market demand curve – reasons for the law of demand – slope of a demand curve – shifts in demand – demand function and demand curve – the meaning of supply – supply function – law of supply – slope of a supply curve – shifts in supply – market equilibrium – price elasticity of demand – measurement of price elasticity – arc elasticity of demand – cross elasticity of demand.

(Relevant sections chapters 5 and 7 of Text -1)

MODULE 2: COST AND REVENUE FUNCTIONS - 14 Hours

Cost function: Average and marginal costs, Short run and long run costs, Shapes of average cost curves in the short run and long run and its explanation, Revenue function, Marginal revenue (MR) and Average Revenue (AR) functions, Relation between MR, AR and Elasticity of demand.

(Relevant sections of chapter 19 & 21 of Text - 1)

MODULE 3: THEORY OF CONSUMER BEHAVIOUR – 12 Hours

Cardinal utility analysis – the Law of diminishing marginal utility – the Law of equi-marginal utility – Indifference curves – Ordinal utility – Indifference map – Marginal rate of substitution – Properties of indifference curves.

(Relevant sections of chapters 9 and 11 of Text -1)

MODULE 4: ECONOMIC APPLICATIONS OF DERIVATIVES - 14 Hours

Economic applications of Derivatives. Marginal, average and total concepts optimizing economic functions - Functions of several variables and partial derivatives, Rules of partial differentiation, Second order partial derivatives, Optimization of multivariable functions, Constrained optimization with Lagrange multipliers, Significance of the Lagrange multiplier, Total and partial derivatives – total derivatives.

Marginal productivity, Income determination, multipliers and comparative statics, Income and cross elasticity of demand, Optimization of multivariable function in Economics constrained optimization of multivariable functions in Economics.

(Chapter 4 – Sections 4.7 and 4.8; chapter 5 and chapter 6 sections 6. 1 to 6.5 – of text 2).

REFERENCES

1. SINGH, PARASHAR, SINGH: ECONOMETRICS & MATHEMATICAL ECONOMICS, S. CHAND & CO. 1997.
2. R.G.D. ALLEN: MATHEMATICAL ANALYSIS FOR ECONOMISTS, MACMILLAN, ELBS.
3. EDWARD T. DOWLING: INTRODUCTION TO MATHEMATICAL ECONOMICS, THIRD EDITION, SCHAUM'S OUTLINE SERIES, TMH.
4. HENDERSON & QUANDT: MICROECONOMIC THEORY: A MATHEMATICAL APPROACH, 3RD EDITION, TMH.
5. TARO YAMANE: MATHEMATICS FOR ECONOMISTS: AN ELEMENTARY SURVEY. SECOND EDITION, PHI.
6. SRINATH BARUAH: BASIC MATHEMATICS AND ITS APPLICATION IN ECONOMICS, MACMILLAN.

ADD ON COURSES

BMMEX01: FREE AND OPEN SOURCE SOFTWARE - LaTeX

Total Hours: 36

Credit: 2

COURSE OBJECTIVES

To teach high quality type setting. It is most often used for medium to large technical or scientific documents but it can be used for almost any form of publishing.

COURSE STRUCTURE

Module 1: INRODUCTION - 8 Hours

Installation of LaTeX, Features of Latex etc.

Module 2: LATEX ON WINDOWS - 12 Hours

Type setting in windows using LaTeX, Type setting using LaTeX in Linux etc.

Module 3: COMPILING - 8 Hours

How to compile different TeX files, common errors while compiling and corrections etc.

Module 4: BEAMER - 8 Hours

Power point presentations using LaTeX

REFERENCES

1. Leslie Lamport, LaTeX: A document preparation system, 2nd Edition, Addison-Wesley 1994
2. F Mittelbach, M Goossens, TheLaTeX companion, 2nd Edition, 2004.

Question Paper Pattern for Examination (Time: 1½ hrs)

Part	Type of Questions	No of questions to be answered	Marks	Total Marks
A	Short answer type	5 out of 7	2	10
B	Short essay type	4 out of 6	5	20
C	Essay type	1 out of 2	10	10
			Grand Total	**40**

BMMEX02: QUANTITATIVE TECHNIQUES FOR COMPETITIVE EXAMINATIONS

Total Hours: 36

Credit: 2

COURSE OBJECTIVES

To prepare students of all streams to approach competitive examinations. Detailed explanation and short cut method for solving problems are to be introduced to students, so that they can acquire better understanding of concepts and problem solving skill.

COURSE STRUCTURE

Module 1 - 8 Hours

Types of numbers, Multiplication and division of numbers, Permutations and combinations – simple applications, Trigonometry introduction, Values of trigonometric ratios of 0^0, 30^0, 45^0, 60^0& 90^0, Heights and distances – Simple cases - (application of sinx, cosx, tanx, and their reciprocals only).

Module 2 - 10 Hours

Probability – Introduction – Sample spaces and events, Simple examples like tossing coin, tossing die etc., Number series, Odd man out, Number puzzles, Clock and calendar, Races and games, Inequality.

Module 3 – 8 Hours

HCF and LCM of numbers, Fractions, Squares and square roots, cube and cube roots, simplifications, Percentage, Profit and loss, Simple interest , Compound interest.

Module 4 - 10 Hours

Ratio and Proportion, Time and work, Partnership, Mixture, Work and wages, Time and distance, Elementary mensuration – Area and perimeter of polygons, Elementary Algebra.

REFERENCES:

1. M Tyra & K Kundan –Concepts of Arithematic, BSC publishing company Pvt. Ltd.
2. S K Sinha, S Satyanarayan, Col. J S Rana (Retd.)-The Complete Reference Manual for CMAT, Arihant Publications Ltd.

Question Paper Pattern for Written Examination (Time: 3 hrs)

Part	Type of Questions	No of questions to be answered	Marks	Total Marks
A	Objective type with negative marks	All 15 questions	2 0.5 marks will be deducted for each incorrect answer	30
B	Objective type	10 out of 12	3	30
C	Objective type with multiple answers	5 out of 7	4 Marks will be awarded only if all correct choices are answered	20
			Grand Total	**80**

BMMEX03: REASONING ABILITY

Total Hours: 36

Credit: 2

COURSE OBJECTIVES

This is an essential foundation for students to prepare systematically for and be successful in competitive examinations. The program inculcates analytical thinking habits and brings home the importance of innovation in problem solving.

COURSE STRUCTURE & TIME DISTRIBUTION

Sl No.	Module	Total Sessions	Hours	Total Time
1	Analogy, Classification	2	1	2
2	Coding – Decoding	2	1	2
3	Alphabet test, Series test, Mathematical operations	2	1	2
4	Blood relations	2	1	2
5	Ranking and Time sequence	2	1	2
6	Sitting Arrangement	2	1	2
7	Direction sense	2	1	2
8	Syllogism, Decision making	4	1	4
9	Statement & Assumptions	3	1	3
10	Statement & Conclusions	3	1	3
11	Cause & effect	3	1	3
12	Input-output	3	1	3
13	Non verbal Reasoning	6	1	6
	Total			36 Hours

REFERENCES

1. B S Sijwali- Verbal and Non-verbal Reasoning, Arihant Publications Ltd, New Delhi
2. Dr. R S Aggarwal – Verbal and Non-verbal Reasoning, S Chand Publications, New Delhi

Question Paper Pattern for Written Examination (Time: 3 hrs)

Part	Type of Questions	No of questions to be answered	Marks	Total Marks
A	Objective type with negative marks	All 10 questions	1	10
B	Objective type	10 out of 12	2	20
C	Objective type	10 out of 12	3	30
D	Objective type	5 out of 7	4	20
			Grand Total	**80**

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