Gangadhar Meher University
SAMBALPUR, ODISHA

UNDERGRADUATE PROGRAMME IN MATHEMATICS
(Courses effective from Academic Year 2017-18)

SYLLABUS OF COURSES OFFERED IN
Core Courses, Generic Elective, Ability Enhancement Compulsory Courses & Skill Enhancement Course

DEPARTMENT OF MATHEMATICS
Gangadhar Meher University
SAMBALPUR, ODISHA

REGULATIONS OF GENERAL ACADEMIC AND EXAMINATION MATTERS FOR BA/B.Sc./B.COM/BBA/BSc.IST EXAMINATIONS

(THREE YEAR DEGREE COURSE) UNDER CHOICE BASED CREDIT SYSTEM AND

SEMESTER SYSTEM

(Effective for the students admitted to First year of Degree course during 2015-16 and afterwards)

CHAPTER-I

(REGULATIONS OF GENERAL ACADEMIC MATTERS)

1. APPLICATION & COMMENCEMENT:

(i)   These regulations shall come into force with effect from the academic session 2015-16.

2. CHOICE-BASED CREDIT SYSTEM (CBCS):

CBCS is a flexible system of learning that permits students to

1. Learn at their own pace.
2. Choose electives from a wide range of elective courses offered by the University Departments.
3. Adopt an inter-disciplinary approach in learning and
4. Make best use of the expertise of available faculty.

3. SEMESTER:

Depending upon its duration, each academic year will be divided into two semesters of 6 months duration. Semesters w-ill be known as either odd semester or even semester. The semester from July to December will be Semesters I, III, V and similarly the Semester from January to June will be Semesters II, IV & VI. A semester shall have minimum of 90 instructional days excluding examination days / Sundays / holidays etc.

4. COURSE:

A Course is a set of instructions pertaining to a pre-determined contents (syllabus), delivery mechanism and learning objectives. Every course offered will have three components associated with the teaching-learning process of the course, namely:

(i)   Lecture – symbolized as L;

(ii)   Tutorial – symbolized as T; and

(iii) Practical – symbolized as P.

In G.M. University, UG programmes have a minimum of 21 courses.

5. CREDIT:

Each course is rated in terms of credits or credit hours. Credit is a kind of weightage given to the contact hours to teach the prescribed syllabus, which is in a modular form. Normally one credit is allocated to 10 contact hours.

Mechanics of credit calculation:

As per G.M. University standard, 1 credit = 10 hours of lectures / contact hours. The contact hours will include all the modes of teaching like lectures / tutorials / laboratory work / field work or other forms. In determining the number of hours of instruction required for a course involving laboratory / field work, 2 hours of laboratory / field work is generally considered equivalent to 1 hour of lecture. In these regulations one credit means one hour of teaching works or two hours of practical works per week.

6. GRADE LETTER:

The Grade letter is an index to indicate the performance of a student in a particular course / paper. It is the transformation of actual marks secured by a student in a course / paper. The Grade letters are O, A+, A, B+, B, C, P, F. There is a range of marks for each grade letter.

7. GRADE POINT:

Grade point is an integer indicating the numerical equivalent of the letter grade / the weightage allotted to each grade letter depending on range of marks awarded in a course / paper.

8. CREDIT POINT (P):

Credit point is the value obtained by multiplying in grade point (G) by the credit (C): $P = G \times C$.

9. SEMESTER GRADE POINT AVERAGE (SGPA):

SGPA is the value obtained by dividing the sum of credit points (P) earned by a student in various courses taken in a semester by the total number of credits earned by the student in that semester. SGPA shall be rounded off to two decimal places.

10. CUMULATIVE GRADE POINT AVERAGE (CGPA):

CGPA is the value obtained by dividing the sum of credit points in all the courses earned by a student for the entire programme, by the total number of credits. CGPA shall be rounded off to two decimal places. CGPA indicates the comprehensive academic performance of a student in a programme.

An overall letter grade (Cumulative Grade) for the entire programme shall be awarded to a student depending on his / her CGPA.

11. COURSE STRUCTURE:

(a) **COURSE:** A course is a component / a paper of a programme. A course may be designed to involve lectures / tutorials / laboratory work / seminar / project work / practical training / report writing / viva voce etc. or a combination of these, to meet effectively the teaching and learning needs and the credits may be assigned suitably.

(b) **TYPES OF COURSES:**

(i) Core Courses (14x6=84 credits)

Core courses comprise a set of at least fourteen papers that are identified as compulsory for the students registered for the UG degree in a particular subject. Core courses shall be spread over all the semesters.

(ii) Ability Enhancement Compulsory Course (04 credits)

The Ability Enhancement Course (AE) Courses may be of two kinds: Ability Enhancement Compulsory Courses (AECC) and Skill Enhancement Courses (SEC). "AECC" courses are the courses based upon the content that leads to Knowledge enhancement; i. Environmental Science and ii. English / MIL Communication. These are mandatory for all disciplines.

(iii) Skill Enhancement Course (SEC) (04 credits)

SEC courses are value-based and / or skill-based and are aimed at providing hands-on-training, competencies, skills, etc. These courses may be chosen from a pool of courses designed to provide value-based and / or skill-based knowledge.

(iv) Elective Courses: 48 credits (24+24)

Elective Course: A course that can be chosen from a number of options other than the core and compulsory courses is known as elective course. An elective may be "Generic Elective" focusing on those courses which add generic proficiency to the student. An elective may be "Discipline Centric" or may be chosen from the main discipline / subject of study called Discipline Specific Elective. Such elective may also include project work / dissertation. It is considered as a special course involving the application of knowledge in solving / analyzing / exploring a real life situation / difficult problem.

The Three year Degree course leading to the Bachelors Degree in Arts/Science/Commerce/BBA/BSc.IST shall be spread over a period of six semesters in three academic years with the following course structure.

Semester	Core Course (6 credits per paper)	Ability Enhancement Compulsory Course (2 credits per paper)	Skill Enhancement Course (2 credits per paper)	Discipline Specific Elective (6 credits per paper)	Generic Elective (6 credits per paper)
I (350 Marks)	CC-I CC-II	AECC-I	-	-	GE-I
II (350 Marks)	CC-III CC-IV	AECC-II	-	-	GE-II
III (450 Marks)	CC-V CC-VI CC-VII	-	SEC-I	-	GE-III
IV (450 Marks)	CC-VIII CC-IX CC-X	-	SEC-II	-	GE-IV
V (400 Marks)	CC-XI CC-XII	-	-	DSE-I DSE-II	-
VI (400 Marks)	CC-XIII CC-XIV	-	-	DSE-III DSE-IV	-

CHAPTER – II
(REGULATION ON EXAMINATION MATTERS)

1. The Examinations

1.1.(a)   A candidate for the Bachelor's Degree in Arts/Science/Commerce/BBA/BSc.IST shall be required to pass each of the following examinations.

(i)	Semester-I	(ii)	Semester-II
(iii)	Semester-III	(iv)	Semester-IV
(v)	Semester-V	(vi)	Semester-VI

Each of the semester examination includes one Mid-Term and one End Term examination.

1.1.(b)   Each student has to register himself / herself within schedule date to be eligible to appear the examination. Unless a student registers himself / herself by filling up examination forms and pays the requisite fees for Semester-I, he/she will not be eligible to sit for semester-II examination. Similarly, he/she will not be eligible to take the subsequent semesters unless he/she registers for the previous semester.

1.1.(c)   A student has to clear all semester examinations within a maximum period of 05 years.

1.2   Examination Calendar

The broad format of the examination calendar for UG classes shall be as follows:

(a)	Mid term examination of odd semesters	…	September
(b)	End Term examination of odd semesters	…	November – December
(c)	Mid term examination of even Semesters	…	February
(d)	End Term examination of even semesters	…	March – April

The detail programme of end term examination shall be notified one month before the commencement of examinations.

1.3.   Mid Term examination

In each semester there shall be one Mid Term examination of one hour / 60 minutes duration irrespective of marks in each paper having theory component. Out of the total marks of a paper, 20% of marks are earmarked for midterm examination.

1.4   End Term Examination

At the end of each semester, there shall be one examination of each paper called End Term examination. It shall cover 80% of the total marks of a paper. A student fulfilling the following conditions is eligible to appear the End Term examination.

   i. A student shall pay the prescribed examination fees and fill up the prescribed

form meant for the examination as per the notification issued by Examination Section (General). No form fill up is allowed before seven days of the commencement of the End-Term examination.

ii. The minimum number of lectures, practicals, seminars, which a student shall be required to attend before being eligible to take any Semester Examination shall not be less than 75% of the total number of lectures, practicals, seminars taken separately during the semester period.

iii. Provided that in exceptional cases the authority may condone the shortage of attendance to the extent of 15%.

iv. Provided further that the authority may condone the shortage of attendance to the extent of 10% over and above 15% in respect of students who represented the college or the state in any National / State Level: Camp, NCC, games or sports during the semester period under reference subject to prior approval and subsequent production of authenticated certificate of participation.

1.5.(a)   Mode of Examination

The duration of examination shall be as follows:

Examination	Total marks	Duration
Theory paper	40 Marks	2 hours
	60/80 Marks	3 hours
Practical papers / Project Papers	25 Marks	3 hours
	50/100 marks	6 hours

1.5.(b)   Mode of question papers

(i)   All examinations except Viva-voce and Project work shall be conducted by means of written paper (Printed, written / typed in English). The papers in Modern Indian Languages shall be set and answered in the respective languages as mentioned in the syllabus.

(ii)   Questions for a paper shall be set covering the total course of that paper either unit wise giving options from each unit unless specified otherwise in the syllabus.

1.5 (c)   Results of examinations

The candidates shall have to appear and secure minimum pass grade in all the paper of a semester examination to be declared as pass. The following 10 – point grading system and corresponding letter grades be implemented in awarding grades and CGPA under CBCS system.

1.6   Award of Grade

The grade awarded to the student in any particular course / paper shall be based on his / her performance in all the tests conducted in a semester for that course / paper. The percentage of marks secured by the students in a particular course / paper shall be converted to a grade and grade point for that course / paper in the manner specified in the following table after conversion in to 100 marks.

% of Marks	Grade	Grade Letter	Grade Point

$>= 90 - 100$	Outstanding	O	10.0
$>= 80 - < 90$	Excellent	A+	9.0
$>= 70 - < 80$	Very good	A	8.0
$>= 60 - < 70$	Good	B+	7.0
$>= 50 - < 60$	Above average	B	6.0
$>= 40 - < 50$	Average	C	5.0
$>= 30 - < 40$	Pass	P	4.0
< 30	Fail	F	0.0
	Absent	S	0.0
	Malpractice	M	0.0

N.B.: Grade 'P' (30% of marks) shall be the pass grade for Theory and Grade 'C' (40% of marks) shall be the pass grade for Practical / Project work / Dissertation.

1.7 Result

1.7(a) In order to pass a course / paper, a candidate has to secure a minimum of Grade Point 4.0 in that course / paper with Grade 'P' (30% of marks) in Theory and Grade 'C' (40% of marks) in Practical / Project work / Dissertation failing which the candidate will be marked 'F' in that course / paper with the Grade Point of 0.0 (below 30 marks) irrespective of the marks secured in that course / paper.

A candidate obtaining Grade 'F' shall be considered as fail and will be required to reappear the course(s) / paper(s) as back paper. The back paper examination shall be held with the normal end semester examination and the students with backlogs shall clear their backlog course(s) / paper(s) along with regular students of lower semesters in the subsequent year within a period of 05 years from the date of admission and with the current syllabus after two consecutive chances.

1.7(b) In order to clear a semester examination, a candidate is required to pass each credit course / paper of that semester and must secure a minimum Semester Grade Point Average (SGPA) of 4.0. The semester result shall be indicated as detail below:-

A. P (Passed or Cleared) indicating that:

- The candidate has cleared every registered course / paper of odd/even semester of the academic year with a minimum Grade Point (GP) of 4.0 in each paper / component of a paper.

He / She has secured SGPA / CGPA of 4.0 or more.

B. NC (Not Cleared) indicating that:

The candidate is eligible for promotion with backlogs to next higher semester if he / she has registered for all the subjects of any semester.

C. 'X' (Not eligible for promotion) indicating that:

The candidate is not eligible for promotion to next higher level, when as he / she has not registered / filled up the form for the different subjects of a semester.

Computation of SGPA and CGP

The UGC recommends the following procedure to compute the Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA)

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

SGPA (Si) = $\sum(C_i X G_i)/\sum C_i$

   Where C_i is the number of credits of i th course and G_i is the grade point scored by the student in the i th course.

ii. The CGPA is also calculated in the same manner taking into account all the courses undergone by a student over all the semesters of a programme, i.e.

CGPA = $\sum(C_i x S_i)/\sum C_i$

Where S_i is the SGPA of the Ist. semester and C_i the total number of credits in that semester.

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

Illustration of Computation of SGPA and CGPA and Format for Transcripts

i. Computation of SGPA and CGPA

Illustration for SGPA

Course	Credit	Grade letter	Grade point	Credit point
Course 1	3	A	8	3X8=24
Course 2	4	B+	7	4X7=28
Course 3	3	B	6	3X6=18
Course 4	3	O	10	3X10=30
Course 5	3	C	5	3X5=15
Course 6	4	B	6	4X6 =24
	20			139

Thus, SGPA = 139/20=6.95

Illustration for CGPA					
Semester-I	Semester-II	Semester-III	Semester-IV	Semester-V	Semester-VI

Credit-20 SGPA:6.9	Credit-22 SGPA:7.8	Credit-25 SGPA:5.6	Credit-26 SGPA:6.0	Credit-26 SGPA:6.3	Credit-25 SGPA:8.0

Thus, CGPA= $\dfrac{20 \times 6.9 + 22 \times 7.8 + 25 \times 5.6 + 26 \times 6.0 + 26 \times 6.3 + 25 \times 8.0}{144}$	=6.73

1.7(c) In order to pass a programme, a candidate must secure a minimum CGPA of 4.5. A candidate securing CGPA of less than 4.5 shall be declared as fail.

The conversion of CGPA to percentage of marks = (CGPA – 0.5) x 10.

The conversion of CGPA into Grade Letter shall be made on the basis of percentage of marks in the manner specified in the following table.

CGPA / OGPA	Grade Letter	Grade	% of Marks after conversion	Classification of Honours
$> = 9.5$	O	Outstanding	$> = 90$	First Class Honours
$> = 8.5 - < 9.5$	A+	Excellent	$> = 80 – < 90$	
$> = 7.5 - < 8.5$	A	Very good	$> = 70 – < 80$	
$> = 6.5 - < 7.5$	B+	Good	$> = 60 – < 70$	
$> = 5.5 - < 6.5$	B	Above average	$> = 50 – < 60$	Second Class Honours
$> = 5.0 - < 5.5$	C	Average	$> = 45 – < 50$	
$> = 4.5 – < 5.0$	P	Pass	$> = 40 - < 45$	Pass without Honours
Below 4.5	F	Fail	< 40	Fail

1.8 Promotion to the next semester

A student shall be promoted to the next higher semester when he/she has appeared and passed in all the courses of the previous semester examinations. However, a student failing to appear / pass semester examination in few or all papers due to some reasons may be admitted to the next semester, provided that such a student shall produce sufficient proof in favour of his/her reason for not being able to appear / pass in some or all papers of the semester examination and has taken readmission in the year. Such students shall be considered as absent / failed candidate and will required to appear the repeat / back paper examination in the next year.

1.9 Repeat / Back Paper Examination

A student who remains absent or failed to secure 30% of marks / SGPA of 4.0 in aggregate has to take the repeat examination. He/she shall repeat all the theory and practical papers of that semester within a period of 5 years from the date of first registration. However, a student who secures more than 30% of marks / SGPA of 4.0 in aggregate but failed in one / some papers, he/she has to take the Back paper

examination in the failed papers only. If the student is unable to clear the back papers in the next two consecutive chances, he/she has to appear the repeat examination of all papers in the third and subsequent chances as per the current syllabus and the marks secured in the previous examinations shall stand cancelled.

During back paper examinations, the higher marks of the papers shall be retained at the time of computation of result. The student passing in all papers in terms of grade point but failing in grade point average, then he / she has to appear the back paper examinations in those papers in which he / she has secured less than the required average grade point to pass. Such students shall have to apply to the Head of the Department in plain paper before one week of the form fill up and also filling the form in due date of the ensuing semester examination by depositing the fees as prescribed by the university. The repeat / back paper examination shall be held with the normal end semester examination.

A student appearing in repeat / back paper examination shall not be awarded distinction even if he/she subsequently fulfils the conditions of distinction and will not be included in the merit list. The final result of the candidate will be determined after taking all the subject wise marks and hard case rule into consideration. Candidates taking repeat / improvement examinations shall not be considered for the merit list and it shall be reflected in the provisional certificate- cum mark sheet but not in the final Degree certificate.

1.10   Improvement Examination

After the publication of final result the student getting 2nd Class (Honours) or Pass without Honours may be allowed to improve his/her performance in the next two year immediately from the year of publication of result. He/she shall be allowed to improve in Honours paper only. However he / she has to fill up the form of all the Honours papers of odd semester (I/III/V) and even semester (II/IV/VI). In such case, the highest mark secured in each paper shall be considered for computation of the mark.

1.11   Discipline in the examination

1.11(a)   The students are allowed to enter the examination hall half an hour before the commencement of examination. A student arriving in the examination hall / room fifteen minutes after the commencement of the examination shall not be ordinarily allowed to sit for the examination. No examinee shall be allowed to go out of the examination hall within one hour of the commencement of examination.

1.11(b)   The students are allowed to enter the examination hall only with a valid admit card and Identity card. Mobile phones and any other electronic gadgets are strictly

prohibited in the examination hall. The possession of such things in the examination hall shall be treated as malpractice.

1.11(c) The possession of unauthorized materials and using it / copying from the scripts of other students / from any other source, sharing his/her answer scripts with other, creating disturbance or acting in a manner, so as to create inconvenience for the other students / invigilators inside the examination hall shall be treated as adoption of unfair means or malpractice.

In case of adoption of unfair means by an examinee in the examination hall / outside, the invigilator shall immediately report to the Centre Superintendent in writing along with the incriminating material recovered from the examinee signed by both the examinee and invigilator. The Centre Superintendent shall refer the matter to the Controller of Examinations for necessary disciplinary action as per the rules and regulations of the University.

1.12 **Issue of Grade sheet, Provisional Certificate, Award of Degree & Gold Medals.**

After the publication of the result of Semester examination, the Controller of Examinations shall issue the grade sheet of each semester as per the prescribed format (Appendix-I) and provisional certificate cum grade sheet after the final semester examination as per the prescribed format (Appendix-II) to the candidates against a prescribed fee collected at the time admission / filling of form. A degree certificate under the official seal of the university and signed by Vice-Chancellor as per the prescribed format (Appendix-III) shall be issued / given to the successful students of a particular course at the convocation or in-absentia on submission of application and fee as prescribed.

For award of gold medals, the University shall form a committee. The best graduate shall be decided from amongst the toppers of each Honours. In case of equality of CGPA, the SGPA of last semester examination shall be considered. The students who have failed / remained absent / improved their marks by repetition or improvement shall not be eligible for University rank or gold medal.

Registrar
G.M. University, Sambalpur

Proposed Scheme for Choice Based Credit System in
Mathematics Honours (Arts & Science)

Semester		Core Course (14)		Ability Enhancement Compulsory Course (AECC) (2)	Skill Enhancement Course (SEC) (2)	Discipline Specific Elective (DSE) (4)	Generic Elective (GE) (4)
I	CC1	Calculus		Environmental Studies			GE I Algebra
	CCII	Algebra					
II	CCIII	Real Analysis		English Communication/ Odia/ Hindi			GE II Real Analysis
	CCIV	Differential Equations					
III	CCV	Theory of Real Functions			SEC - I Communicative English & Writing Skills		GE III Group Theory I
	CCVI	Group Theory I					
	CCVII	PDE and Systems of ODE					
IV	CCVIII	Numerical Methods			SEC - II Graph Theory		GEIV Ring Theory and Linear Algebra I
	CCIX	Riemann Integration and Series of Functions					
	CCX	Ring Theory and Linear Algebra I					
V	CCXI	Multivariate Calculus				DSE-I Number Theory	
	CCXII	Group Theory II				DSE-II Probability and Statistics	
VI	CCXIII	Metric Spaces and Complex Analysis				DSE- III Linear Programming	
	CC XIV	Ring Theory and Linear Algebra II				DSE- IV Dissertation /Project Work	

B. Sc. (Hons.) Mathematics

Semester	Course Name	Course Offered	Title Of Paper	Credits	Marks
I 4 Papers (350 Marks) 20 credits	AECC	Ability Enhancement Compulsory Course-I	**Environmental Studies**	**2**	**50 (10+40)**
	Generic Elective	Generic Elective –I	**Algebra**	4	**75 (15+60)**
		Generic Elective - I Project	**Project**	2	25
	Core Course	Core course-I	**Calculus**	4	**75 (15+60)**
		Core Course-I Practical	**Project**	2	25
		Core course-II	**Algebra**	4	**75 (15+60)**
		Core Course-II Practical	**Project - MS- Excel - I**	2	25
II 4 Papers (350 Marks) 20 credits	AECC	Ability Enhancement Compulsory Course-II	**English Communication/ Odia/ Hindi**	**2**	**50 (10+40)**
	Generic Elective	Generic Elective –II	**Real Analysis**	4	**75 (15+60)**
		Generic Elective –II Practical	**Project**	2	25
	Core Course	Core course-III	**Real Analysis**	4	**75 (15+60)**
		Core Course-III Practical	**MS - Excel- II**	2	25
		Core course-IV	**Differential Equations**	4	**75 (15+60)**
		Core Course-IV Practical	**Practical**	2	25
III 5 Papers (450 Marks) 26 credits	SEC	Skill Enhancement Course -I	**Communicative English & Writing Skills**	**2**	**50 (10+40)**
	Generic Elective	Generic Elective -III	**Group Theory I**	4	**75 (15+60)**
		Generic Elective -III Project	**Project**	2	25
	Core Course	Core course-V	**Theory of Real Functions**	4	**75 (15+60)**
		Core Course-V Practical	**MS - Word**	2	25
		Core course-VI	**Group Theory I**	4	**75 (15+60)**
		Core Course-VI Practical	**PMs - Power Point**	2	25
		Core course-VII	**PDE and Systems of ODE**	4	**75 (15+60)**
		Core Course-VII - Practical	**Project**	2	25
IV 5 Papers (450 Marks) 26 credits	SEC	Skill Enhancement Course -II	**Graph Theory**	**2**	**50 (10+40)**
	Generic Elective	Generic Elective – IV	**Ring Theory and Linear Algebra I**	4	**75 (15+60)**
		Generic Elective – IV Project	**Project**	2	25
	Core Course	Core course-VIII	**Numerical Methods**	4	**75 (15+60)**
		Core Course-VIII Practical	**Practical**	2	25
		Core course-IX	**Riemann Integration and Series of Functions**	4	**75 (15+60)**
		Core Course-IX Project	**Project**	2	25
		Core course-X	**Ring Theory and Linear Algebra I**	4	**75 (15+60)**
		Core Course-X Project	**Project**	2	25
V 4 Papers (400 Marks) 24 credits	DSE	Discipline Specific Elective –I	**Number Theory**	4	**75 (15+60)**
		Discipline Specific Elective -I - Project	**Project**	2	25
		Discipline Specific Elective –II	**Probability and Statistics**	4	**75 (15+60)**
		Discipline Specific Elective- II - Project	**Project**	2	25
	Core Course	Core course-XI	**Multivariate Calculus**	4	**75 (15+60)**
		Core Course-XI Project	**Project**	2	25
		Core course-XII	**Group Theory II**	4	**75 (15+60)**
		Core Course-XII Practical	**Project**	2	25
VI 4 Papers (400 Marks) 24 credits	DSE	Discipline Specific Elective – III	**Linear Programming**	4	**75 (15+60)**
		Discipline Specific Elective –III - Project	**Project**	2	25
		Discipline Specific Elective-IV	**Dissertation/ Project Work**	6	**100**
	Core Course	Core course-XIII	**Metric Spaces and Complex Analysis**	4	**75 (15+60)**
		Core Course-XIII Project	**Project**	2	25
		Core course-XIV	**Ring Theory and Linear Algebra II**	4	**75 (15+60)**
		Core Course-XIV Project	**Project**	2	25
	Total Credits			**140**	**2400**

SEMESTER – I

Ability Enhancement Compulsory Course (AECC: I) Environment Studies
Credits – 2, Full marks 50 (Mid Term 10 + End Term 40)
(Unit wise question pattern, answer one question from each unit)

Unit I: Introduction to environmental studies
- Multidisciplinary nature of environmental studies;
- Scope and importance; Concept of sustainability and sustainable development.

(2 lecturers)

Ecosystems
- What is an ecosystem? Structure and function of ecosystem; Energy flow in an ecosystem: food chains, food webs and ecological succession. Case studies of the following ecosystems :
  a) Forest ecosystem
  b) Grassland ecosystem
  c) Desert ecosystem
  d) Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

Unit II : Natural Resources : Renewable and Non-renewable Resources
- Land resources and landuse change; Land degradation, soil erosion and desertification.
- Deforestation: Causes and impacts due to mining, dam building on environment, forests, biodiversity and tribal populations.
- Water: Use and over-exploitation of surface and ground water, floods, droughts, conflicts over water (international & inter-state).
- Energy resources : Renewable and non renewable energy sources, use of alternate energy sources, growing energy needs, case studies.

Unit III: Biodiversity and Conservation
- Levels of biological diversity : genetic, species and ecosystem diversity; Biogeographic zones of India; Biodiversity patterns and global biodiversity hot spots
- India as a mega-biodiversity nation; Endangered and endemic species of India
- Threats to biodiversity: Habitat loss, poaching of wildlife, man-wildlife conflicts, biological invasions; Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.
- Ecosystem and biodiversity services: Ecological, economic, social, ethical, aesthetic and Informational value.

Unit IV: Environmental Pollution
- Environmental pollution : types, causes, effects and controls; Air, water, soil and noise pollution
- Nuclear hazards and human health risks
- Solid waste management: Control measures of urban and industrial waste.
- Pollution case studies.

Unit V: Environmental Policies & Practices
- Climate change, global warming, ozone layer depletion, acid rain and impacts on human communities and agriculture
- Environment Laws: Environment Protection Act; Air (Prevention & Control of Pollution) Act; Water (Prevention and control of Pollution) Act; Wildlife Protection Act; Forest Conservation Act. International agreements: Montreal and Kyoto protocols and Convention on Biological Diversity (CBD).
- Nature reserves, tribal populations and rights, and human wildlife conflicts in Indian context.

Human Communities and the Environment
- Human population growth: Impacts on environment, human health and welfare.
- Resettlement and rehabilitation of project affected persons; case studies.
- Disaster management : floods, earthquake, cyclones and landslides.
- Environmental movements : Chipko, Silent valley, Bishnois of Rajasthan.
- Environmental ethics: Role of Indian and other religions and cultures in environmental conservation.
- Environmental communication and public awareness, case studies (e.g., CNG vehicles in Delhi).

Suggested Readings:

1. Carson, R. 2002. *Silent Spring*. Houghton Mifflin Harcourt.
2. Gadgil, M., & Guha, R. 1993. *This Fissured Land: An Ecological History of India*. Univ. of California Press.
3. Gleeson, B. and Low, N. (eds.) 1999. *Global Ethics and Environment*, London, Routledge.
4. Gleick, P. H. 1993. *Water in Crisis*. Pacific Institute for Studies in Dev., Environment & Security. Stockholm Env. Institute, Oxford Univ. Press.
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7. McCully, P. 1996. *Rivers no more: the environmental effects of dams* (pp. 29-64). Zed Books.
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11. Rao, M.N. & Datta, A.K. 1987. *Waste Water Treatment*. Oxford and IBH Publishing Co. Pvt. Ltd.
12. Raven, P.H., Hassenzahl, D.M. & Berg, L.R. 2012. *Environment*. 8th edition. John Wiley & Sons.
13. Rosencranz, A., Divan, S., & Noble, M. L. 2001. *Environmental law and policy in India. Tripathi 1992*.
14. Sengupta, R. 2003. *Ecology and economics*: An approach to sustainable development. OUP.
15. Singh, J.S., Singh, S.P. and Gupta, S.R. 2014. *Ecology, Environmental Science and Conservation*. S. Chand Publishing, New Delhi.
16. Sodhi, N.S., Gibson, L. & Raven, P.H. (eds). 2013. *Conservation Biology*: *Voices from the Tropics*. John Wiley & Sons.
17. Thapar, V. 1998. *Land of the Tiger*: *A Natural History of the Indian Subcontinent*.
18. Warren, C. E. 1971. *Biology and Water Pollution Control*. WB Saunders.
19. Wilson, E. O. 2006. *The Creation: An appeal to save life on earth*. New York: Norton.
20. World Commission on Environment and Development. 1987. *Our Common Future*. Oxford University Press.

Mathematics GE I: Algebra
(Credits: Theory-04, Practicals-02)
Full Marks: 75 (Midterm − 15+ End term − 60)
(Unit Wise question pattern- Answer one question from each Unit)

Unit I: Polar representation of complex numbers, n^{th} roots of unity, De Moivre's theorem for rational indices and its applications. Equivalence relations, Functions, Composition of functions, Invertible functions, One to one correspondence and cardinality of a set,

Unit II: Well-ordering property of positive integers, Division algorithm, Divisibility and Euclidean algorithm, Congruence relation between integers, Principles of Mathematical Induction, statement of Fundamental Theorem of Arithmetic.

Unit III: Systems of linear equations, row reduction and echelon forms, vector equations, the matrix equation Ax=b, solution sets of linear systems, applications of linear systems, linear independence.

Unit IV: Introduction to linear transformations, matrix of a linear transformation, inverse of a matrix, characterizations of invertible matrices.

Unit V: Subspaces of R^n, dimension of subspaces of R^n and rank of a matrix, Eigen values, Eigen Vectors and Characteristic Equation of a matrix.

Books Recommended

1. Titu Andreescu and Dorin Andrica, *Complex Numbers from A to Z*, Birkhauser, 2006.

2. Edgar G. Goodaire and Michael M. Parmenter, *Discrete Mathematics with Graph Theory,* 3rd Ed., Pearson Education (Singapore) P. Ltd., Indian Reprint, 2005**.**

3. David C. Lay, *Linear Algebra and its Applications,* 3rd Ed., Pearson Education Asia, Indian Reprint, 2007.

PROJECT PAPER - 25 MARKS

Mathematics CC I: Calculus
(Credits: Theory-04, Practicals-02)
Full Marks: 75 (Midterm − 15+ End term − 60)
(Unit Wise question pattern- Answer one question from each Unit)

Unit I: Hyperbolic functions, higher order derivatives, Leibniz rule and its applications to problems of type $e^{ax+b}\sin x$, $e^{ax+b}\cos x$, $(ax+b)^n \sin x$, $(ax+b)^n \cos x$, concavity and inflection points, asymptotes, curve tracing in Cartesian coordinates, tracing in polar coordinates of standard curves, L' Hospital's rule, applications in business, economics and life sciences.

Unit II: Reduction formulae, derivations and illustrations of reduction formulae of the type $\int \sin^n x\, dx$, $\int \cos^n x\, dx$, $\int \tan^n x\, dx$, $\int \sec^n x\, dx$, $\int (\log x)^n\, dx$, $\int \sin^n x \sin^m x\, dx$, volumes by slicing, disks and washers methods, volumes by cylindrical shell.

Unit III: Parametric equations, parameterizing a curve, arc length, arc length of parametric curves, area of surface of revolution. Techniques of sketching conics, reflection properties of conics, rotation of axes and second degree equations, classification into conics using the discriminant, polar equations of conics.

Unit IV: Triple product, introduction to vector functions, operations with vector-valued functions, limits and continuity of vector functions,

Unit V: Differentiation and integration of vector functions, tangent and normal components of acceleration, modeling ballistics and planetary motion, Kepler's second law.

List of Practical's (using any software) - 25 Marks

1. Plotting of graphs of function e^{ax+b}, $\log(ax+b)$, $1/(ax+b)$, $\sin(ax+b)$, $\cos(ax+b)$, $|ax+b|$ and to illustrate the effect of a and b on the graph.
2. Plotting the graphs of polynomial of degree 4 and 5, the derivative graph, the second derivative graph and comparing them.
3. Sketching parametric curves (Eg. Trochoid, cycloid, epicycloids, hypocycloid).
4. Obtaining surface of revolution of curves.
5. Tracing of conics in cartesian coordinates/ polar coordinates.
6. Sketching ellipsoid, hyperboloid of one and two sheets, elliptic cone, elliptic. paraboloid, hyperbolic paraboloid using cartesian coordinates.
7. Matrix operation (addition, multiplication, inverse, transpose).

Books Recommended

1. G.B. Thomas and R.L. Finney, *Calculus*, 9th Ed., Pearson Education, Delhi, 2005.

2. M.J. Strauss, G.L. Bradley and K. J. Smith, *Calculus,* 3rd Ed., Dorling Kindersley (India) P. Ltd. (Pearson Education), Delhi, 2007.

3. H. Anton, I. Bivens and S. Davis, *Calculus,* 7th Ed., John Wiley and Sons (Asia) P. Ltd., Singapore, 2002.

4. R. Courant and F. John, *Introduction to Calculus and Analysis* (Volumes I & II), Springer- Verlag, New York, Inc., 1989.

Mathematics CC II: Algebra
(Credits: Theory-04, Practicals-02)
Full Marks: 75 (Midterm − 15+ End term − 60)
(Unit Wise question pattern- Answer one question from each Unit)

Unit I: Polar representation of complex numbers, n^{th} roots of unity, De Moivre's theorem for rational indices and its applications. Equivalence relations, Functions, Composition of functions, Invertible functions, One to one correspondence and cardinality of a set,

Unit II: Well-ordering property of positive integers, Division algorithm, Divisibility and Euclidean algorithm, Congruence relation between integers, Principles of Mathematical Induction, statement of Fundamental Theorem of Arithmetic.

Unit III: Systems of linear equations, row reduction and echelon forms, vector equations, the matrix equation Ax=b, solution sets of linear systems, applications of linear systems, linear independence.

Unit IV: Introduction to linear transformations, matrix of a linear transformation, inverse of a matrix, characterizations of invertible matrices.

Unit V: Subspaces of R^n, dimension of subspaces of R^n and rank of a matrix, Eigen values, Eigen Vectors and Characteristic Equation of a matrix.

Books Recommended

4. Titu Andreescu and Dorin Andrica, *Complex Numbers from A to Z*, Birkhauser, 2006.

5. Edgar G. Goodaire and Michael M. Parmenter, *Discrete Mathematics with Graph Theory,* 3rd Ed., Pearson Education (Singapore) P. Ltd., Indian Reprint, 2005**.**

6. David C. Lay, *Linear Algebra and its Applications,* 3rd Ed., Pearson Education Asia, Indian Reprint, 2007.

PRACTICAL - 25 MARKS

MS- EXCEL- 1

SEMESTER II
Ability Enhancement Compulsory Course (AECC II) ENGLISH
Full marks 50 (Mid Term 10 + End Term 40)
(Unit wise question pattern, answer one question from each unit)

This course aims at enhancing the English language proficiency of undergraduate students in humanity, science and commerce streams to prepare them for the academic, social and professional expectations during and after the course. The course will help develop academic and social English competencies in speaking, listening, pronunciation, reading and writing, grammar and usage, vocabulary, syntax, and rhetorical patterns. Students, at the end of the course, should be able to use English appropriately and effectively for further studies or for work where English is used as the language of communication.

Unit I: Reading Comprehension

- Locate and remember the most important points in the reading
- Interpret and evaluate events, ideas, and information
- Read "between the lines" to understand underlying meanings
- Connect information to what they already know

Book Prescribed

Vistas and Visions: An Anthology of Prose and Poetry. Texts to be studied

PROSE
- Playing the English Gentleman (M.K. Gandhi)
- The Need for Excellence (N.R. Narayana Murthy)
- The Last Leaf (O. Henry)

POETRY
- One Day I Wrote Her Name (Edmund Spenser)
- Miracles (Walt Whitman)
- The Felling of the Banyan Tree (DilipChitre)

Unit II: Writing

1. Expanding an Idea
2. Writing a Memo
3. Report Writing
4. Writing a Business Letter
5. Letters to the Editor
6. CV & Resume Writing
7. Covering Letter
8. Writing Formal Email
9. Elements of Story Writing
10. Note Making

Unit III: Language functions in listening and conversation

1. Discussion on a given topic in pairs
2. Speaking on a given topic individually
   (Practice to be given using speaking activities from the prescribed textbooks)

Grammar and Usage

1.   Simple and Compound Sentences
2.   Complex Sentences
3.   Noun Clause
4.   Adjective Clause
5.   Adverb Clause
6.   The Conditionals in English
7.   Words and their features
8.   Phrasal Verbs
9.   Collocation
10.   Using Modals
11.   Use of Passives
12.   Use of Prepositions
13.   Subject-verb Agreement
14.   Sentence as a system
15.   Common Errors in English Usage

Examination pattern

Each reading and writing question will invite a 200 word response.
Language function questions set in context will carry 01 mark per response. There will be 15 bit questions.
Midterm test 10 marks
End Term Total 40 marks
Unit I- Reading: 05 questions (03x 05 qns= 15 marks)
Unit II- Writing: 03 questions (05 x 03 qns= 15 marks)
Unit III- Grammar & usage: 10 qns (01x 10 qns = 10 marks)
Grammar questions must be set in contexts; not as isolated sentences as used for practice in the prescribed textbook.

All grammar and writing activities in the textbook

'Vistas and Visions: An Anthology of Prose and Poetry' (Ed.) Kalyani Samantray, Himansu S. Mohapatra, Jatindra K. Nayak, Gopa Ranjan Mishra, Arun Kumar Mohanty. (Orient Black Swan Publisher)

Ability Enhancement Compulsory Course (AECC -II) ODIA
Full marks 50 (Mid Term 10 + End Term 40)
(Unit wise question pattern, answer one question from each unit)

ପ୍ରଥମ ଏକକ : କବିତା : ଭକ୍ତି - ଗଙ୍ଗାଧର ମେହେର

ଗ୍ରାମପଥ - ବିନୋଦ ଚନ୍ଦ୍ର ନାୟକ

ଦ୍ୱିତୀୟ ଏକକ : ଗଳ୍ପ :   ମାଗୁଣିର ଶଗଡ - ଗୋଦାବରୀଶ ମହାପାତ୍ର

ଗୋପପୁର - ରାମଚନ୍ଦ୍ର ବେହେରା

ତୃତୀୟ ଏକକ : ପ୍ରବନ୍ଧ :   ଜନ୍ମଭୂମି - କୃଷ୍ଟଚନ୍ଦ୍ର ପାଣିଗ୍ରାହୀ

ଆଧୁନିକ - ହରେକୃଷ୍ଣ ମହତାବ

ଚତୁର୍ଥ ଏକକ : ପ୍ରବନ୍ଧ ରଚନା, ପତ୍ରଲିଖନ, ସମ୍ପାଦଲିଖନ

ପଞ୍ଚମ ଏକକ : ବ୍ୟାକରଣ – ଭ୍ରମ ସଂଶୋଧନ, ବିପରିତାର୍ଥବୋଧକ ଶବ୍ଦ, ସମୋଚ୍ଚାରିତ ଭିନ୍ନାର୍ଥବୋଧକ ଶବ୍ଦ

ଆନ୍ତଃପରୀକ୍ଷା ପାଇଁ ୧୦ ମାର୍କ ପ୍ରଶ୍ନ ପଡିବ । (୧ x ୧୦ = ୧୦)

ବିଶ୍ୱବିଦ୍ୟାଳୟସ୍ତରୀୟ ମୁଖ୍ୟ ପରୀକ୍ଷାରେ ନିମ୍ନମତେ ପ୍ରଶ୍ନ ପଡିବ:

ପ୍ରଥମ ଏକକରୁ ଚତୁର୍ଥ ଏକକ ପର୍ଯ୍ୟନ୍ତ ପ୍ରତ୍ୟେକ ଏକକରୁ ୨ଟି ଲେଖାଏଁ ପ୍ରଶ୍ନାନ ପଡିବ। ବିଦ୍ୟାର୍ଥୀ ପ୍ରତ୍ୟେକ ଏକକରୁ ଗୋଟିଏ ଲେଖାଏଁ ପ୍ରଶ୍ନ ର ଉତ୍ତର ଦେବେ ।   (୪ x ୮ = ୩୨)

ପଞ୍ଚମ ଏକକରୁ ୧୫ ଟି ଅତି ସଂକ୍ଷିପ୍ତ ପପ୍ରଶ୍ନ ପଡିବ । ବିଦ୍ୟାର୍ଥୀ ନିର୍ଦ୍ଦେଶ ଅନୁଯାୟୀ ୮ ଟି ପ୍ରଶ୍ନର ଉତ୍ତର ଦେବେ । (୮x୧=୮)

ଗ୍ରନ୍ଥ ସୂଚୀ

୧. କବିତାଶ୍ରୀ   -   ସଂ. – କୃଷ୍ଟଚରଣ ବେହେରା

୨. ଗଳ୍ପ ଦିଗନ୍ତ -   ସଂ. – ସୁରେନ୍ଦ୍ର ନାଥ ଦାସ

୩. ଭାଷଣ କଳା ଓ ଅନ୍ୟାନ୍ୟ ପ୍ରସଙ୍ଗ - ଡ. କୃଷ୍ଟଚନ୍ଦ୍ର ପ୍ରଧାନ

୪ . ପ୍ରବନ୍ଧ ଗୌରବ   -   ସଂ.- ପ୍ର. କୃଷ୍ଟଚାନ୍ଦ୍ର ପ୍ରଧାନ

୫.   ସାରସ୍ୱତ ପ୍ରବନ୍ଧ ପତ୍ରମାଳା -

୬. ବିଶ୍ୱବିଦ୍ୟାଳୟ ପ୍ରବନ୍ଧମାଳା - ପ୍ର. କୃଷ୍ଟଚାନ୍ଦ୍ର ପ୍ରଧାନ

୭. ସର୍ବସାର ବ୍ୟାକରଣ   - ଶ୍ରୀଧର ଦାସ ଓ ନାରାୟଣ ମହାପାତ୍ର

୮. ସାରସ୍ୱତ ବ୍ୟାବହାରିକ ବ୍ୟାକରଣ - ଡ. କୃଷ୍ଟଚାନ୍ଦ୍ର ପ୍ରଧାନ ଓ ସାଥୀ

Ability Enhancement Compulsory Course (AECC - II): Hindi
Full marks 50 (Mid Term 10 + End Term 40)
(Unit wise question pattern, answer one question from each unit)

हिन्दी भाषा, ब्याकरण एबं रचना

Unit I: हिन्दी के बिबिध रूप

   (क) राजभाषा, संचारभाषा (श्रब्या माध्यम - दृश्य) (8)

   (ख) सरकारी पत्र लेखन (ब्याबहरिक पक्ष) नमूना (8)

Unit II: अपाठीत गदयांश (8)

Unit III: अशुद्धि लेखन

   (क) शब्द शुद्धिकरण (4)

  (ख) वाक्य शुद्धिकरण (4)

Unit IV: शब्द ज्ञान

   (क) पर्याय वाची (4)

   (ख) अनेक शब्द केलिए एक शब्द (4)

Unit V: प्रशासनिक शब्दावली

   (क) अँग्रेजी से हिन्दी (4)

   (ख) हिन्दी से अँग्रेजी (4)

Unit I: यूनिट एक (क) बिभाग से एक प्रश्न एबं (ख) बिभाग से एक प्रश्न पुछे जाएंगे ।
   एक का उत्तर लिखना होगा ।   (8)

Unit II: एक अपठित गद्यांश दिया जाएगा । जिनमे से चार प्रश्न पूछे जाएंगे । चारों प्रश्नो का उत्तर
   देना अनिवार्य होगा ।   (8)

Unit III: (क)   छ: शब्द शुद्धिकरण के लिए दिये जाएंगे । चार का उत्तर लिखना होगा । (4)
   (ख)   छ: वाक्य शुद्धिकरण के लिए दिये जाएंगे । चार का उत्तर लिखना होगा । (4)

Unit IV: (क) छ: पर्यायवाची शब्द दिये जाएंगे   , जिनमे से चार शब्दों का पर्यायवाची लिखना होगा । (4)
   (ख)   छ: अनेक शब्दों के लिए एक शब्द दिये जाएंगे   , जिनमे से चार का उत्तर लिकना होगा । (4)

Unit V: (क) छ: अँग्रेजी शब्द दिये जाएंगे   , जिनमे से चार का हिन्दी रूप लिखना होगा । (4)
   (ख)   छ: हिन्दी शब्द दिये जाएंगे   , जिनमे से चार का अँग्रेजी प्रतिरूप लिखना होगा । (4)

Mathematics GE II: Real Analysis
(Credits: Theory-04, Practicals-02)
Full Marks: 75 (Midterm – 15+ End term – 60)
(Unit Wise question pattern- Answer one question from each Unit)

Unit I: Review of Algebraic and Order Properties of R, δ-neighborhood of a point in R, Idea of countable sets, uncountable sets and uncountability of R. Bounded above sets, Bounded below sets, Bounded Sets, Unbounded sets, Suprema and Infima,

Unit II: The Completeness Property of R, The Archimedean Property, Density of Rational (and Irrational) numbers in R, Intervals. Limit points of a set, Isolated points, Illustrations of Bolzano-Weierstrass theorem for sets.

Unit III: Sequences, Bounded sequence, Convergent sequence, Limit of a sequence. Limit Theorems, Monotone Sequences, Monotone Convergence Theorem.

Unit IV: Subsequences, Divergence Criteria, Monotone Subsequence Theorem (statement only), Bolzano Weierstrass Theorem for Sequences. Cauchy sequence, Cauchy's Convergence Criterion.

Unit V: Infinite series, convergence and divergence of infinite series, Cauchy Criterion, Tests for convergence: Comparison test, Limit Comparison test, Ratio Test, Cauchy's n^{th} root test, Integral test, Alternating series, Leibniz test, Absolute and Conditional convergence.

Books Recommended

1. R.G. Bartle and D. R. Sherbert, *Introduction to Real Analysis,* 3rd Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2002.

2. Gerald G. Bilodeau , Paul R. Thie, G.E. Keough, *An Introduction to Analysis,* 2nd Ed., Jones & Bartlett, 2010.

3. Brian S. Thomson, Andrew. M. Bruckner and Judith B. Bruckner, *Elementary Real Analysis,* Prentice Hall, 2001.

1. S.K. Berberian, *A First Course in Real Analysis*, Springer Verlag, New York, 1994.

Project Paper - 25 marks

Mathematics CC III: Real Analysis
(Credits: Theory-04, Practicals-02)
Full Marks: 75 (Midterm – 15+ End term – 60)
(Unit Wise question pattern- Answer one question from each Unit)

Unit I: Review of Algebraic and Order Properties of *R,* ð-neighborhood of a point in *R,* Idea of countable sets, uncountable sets and uncountability of *R.* Bounded above sets, Bounded below sets, Bounded Sets, Unbounded sets, Suprema and Infima,

Unit II: The Completeness Property of *R,* The Archimedean Property, Density of Rational (and Irrational) numbers in *R,* Intervals. Limit points of a set, Isolated points, Illustrations of Bolzano-Weierstrass theorem for sets.

Unit III: Sequences, Bounded sequence, Convergent sequence, Limit of a sequence. Limit Theorems, Monotone Sequences, Monotone Convergence Theorem.

Unit IV: Subsequences, Divergence Criteria, Monotone Subsequence Theorem (statement only), Bolzano Weierstrass Theorem for Sequences. Cauchy sequence, Cauchy's Convergence Criterion.

Unit V:
Infinite series, convergence and divergence of infinite series, Cauchy Criterion, Tests for convergence: Comparison test, Limit Comparison test, Ratio Test, Cauchy's n^{th} root test, Integral test, Alternating series, Leibniz test, Absolute and Conditional convergence.

Books Recommended

1   R.G. Bartle and D. R. Sherbert, *Introduction to Real Analysis,* 3rd Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2002.
2.   Gerald G. Bilodeau , Paul R. Thie, G.E. Keough, *An Introduction to Analysis,* 2nd Ed., Jones & Bartlett, 2010.

3.   Brian S. Thomson, Andrew. M. Bruckner and Judith B. Bruckner, *Elementary Real Analysis,* Prentice Hall, 2001.

4.   S.K. Berberian, *A First Course in Real Analysis*, Springer Verlag, New York, 1994.

Practical - MS EXCEL - 2
Marks - 25

Mathematics CC IV: Differential Equations
(Credits: Theory-04, Practicals-02)
Full Marks: 75 (Midterm − 15+ End term − 60)
(Unit Wise question pattern- Answer one question from each Unit)

Unit I: Differential equations and mathematical models. General, particular, explicit, implicit and singular solutions of a differential equation.

Unit II: Exact differential equations and integrating factors, separable equations and equations reducible to this form, linear equation and Bernoulli equations, special integrating factors and transformations.

Unit III: Introduction to compartmental model, exponential decay model, lake pollution model (case study of Lake Burley Griffin), drug assimilation into the blood (case of a single cold pill, case of a course of cold pills), exponential growth of population, limited growth of population, limited growth with harvesting.

General solution of homogeneous equation of second order, principle of super position for homogeneous equation,

Unit IV: Wronskian: its properties and applications, Linear homogeneous and non-homogeneous equations of higher order with constant coefficients,

Unit V: Euler's equation, method of undetermined coefficients, method of variation of parameters. Equilibrium points, Interpretation of the phase plane, predatory-prey model and its analysis, epidemic model of influenza and its analysis, battle model and its analysis.

List of Practical (using any software) - 25 Marks

1. Plotting of second order solution family of differential equation.
2. Plotting of third order solution family of differential equation
3. Growth model (exponential case only).
4. Decay model (exponential case only).
5. Lake pollution model (with constant/seasonal flow and pollution concentration).
6. Case of single cold pill and a course of cold pills.
7. Limited growth of population (with and without harvesting).
8. Predatory-prey model (basic volterra model, with density dependence, effect of DDT, two prey one predator).
9. Epidemic model of influenza (basic epidemic model, contagious for life, disease with carriers).

10. Battle model (basic battle model, jungle warfare, long range weapons).
11. Plotting of recursive sequences.
12. Study the convergence of sequences through plotting.
13. Verify Bolzano-Weierstrass theorem through plotting of sequences and hence identify convergent subsequences from the plot
14. Study the convergence/divergence of infinite series by plotting their sequences of partial sum.
15. Cauchy's root test by plotting n^{th} roots.
16. Ratio test by plotting the ratio of nth and $(n+1)^{th}$ term.

Books Recommended:

1. Belinda Barnes and Glenn R. Fulford, *Mathematical Modeling with Case Studies, A Differential Equation Approach using Maple and Matlab,* 2nd Ed., Taylor and Francis group, London and New York, 2009.

2. C.H. Edwards and D.E. Penny, *Differential Equations and Boundary Value problems Computing and Modeling,* Pearson Education India, 2005.

3. S.L. Ross, *Differential Equations,* 3rd Ed., John Wiley and Sons, India, 2004.

4. Martha L Abell, James P Braselton, *Differential Equations with MATHEMATICA,* 3rd Ed., Elsevier Academic Press, 2004.

SEMESTER - III
English SEC-I: Communicative English & English Writing skill
Full marks 50 (Mid Term 10 + End Term 40)
(Unit wise question pattern, answer one question from each unit)

Unit I: Introduction to the essentials of Business Communication: Theory and practice
Communication: Definition, Process, Purpose, Communication Network, Types of Communication, Barriers to communication

Unit II: Mechanics of Writing
Stages of writing, Preparing Notes, Style and Tone, linguistic unity, coherence and cohesion, How to Compose Business Messages, Citing references, and using bibliographical

Unit III: Writing a project report
Report planning, Types of Reports, Developing an Outline, Sections of the Report

Unit IV: Writing minutes of meetings, Circular, Notices, Memos, Agenda

Unit V: E-correspondence: E-mails, Business Letter Format, Styles, Types of Letter

Suggested Readings:
1.   Scot, O.; Contemporary *Business Communication*. Biztantra, New Delhi.

2.   Lesikar, R.V. &Flatley, M.E.; *Basic Business Communication Skills for Empowering the Internet Generation*, Tata McGraw Hill Publishing Company Ltd. New Delhi.

3.   Ludlow, R. & Panton, F.; *The Essence of Effective Communications*, Prentice Hall of India Pvt. Ltd., New Delhi.

4.   R. C. Bhatia, *Business Communication*, Ane Books Pvt Ltd, New Delhi

Mathematics GE III: Group Theory I
(Credits: Theory-04, Project-02)
Full Marks: 75 (Midterm – 15+ End term – 60)
(Unit Wise question pattern- Answer one question from each Unit)

Unit I: Symmetries of a square, Dihedral groups, definition and examples of groups including permutation groups and quaternion groups (illustration through matrices), elementary properties of groups.

Unit II: Subgroups and examples of subgroups, centralizer, normalizer, center of a group, product of two subgroups. Properties of cyclic groups, classification of subgroups of cyclic groups.

Unit III: Cycle notation for permutations, properties of permutations, even and odd permutations, alternating group, properties of cosets, Lagrange's theorem and consequences including Fermat's Little theorem.

Unit IV: External direct product of a finite number of groups, normal subgroups, factor groups, Cauchy's theorem for finite abelian groups.

Unit V: Group homomorphisms, properties of homomorphisms, Cayley's theorem, properties of isomorphisms, First, Second and Third isomorphism theorems.

Books Recommended

1. John B. Fraleigh, *A First Course in Abstract Algebra*, 7th Ed., Pearson, 2002**.**

2. M. Artin, *Abstract Algebra*, 2nd Ed., Pearson, 2011.

3. Joseph A. Gallian, *Contemporary Abstract Algebra,* 4th Ed., Narosa Publishing House, New Delhi, 1999.

4. Joseph J. Rotman, *An Introduction to the Theory of Groups,* 4th Ed., Springer Verlag, 1995.

5. I.N. Herstein, *Topics in Algebra*, Wiley Eastern Limited, India, 1975.

PRACTICAL –
Marks - 25

Mathematics-CC V: Theory of Real Functions
(Credits: Theory-04, Practicals-02)
Full Marks: 75 (Midterm − 15+ End term − 60)
(Unit Wise question pattern- Answer one question from each Unit)

Unit I: Limits of functions ($\in - \eth$ approach), sequential criterion for limits, divergence criteria. Limit theorems, one sided limits. Infinite limits and limits at infinity. Continuous functions, sequential criterion for continuity and discontinuity. Algebra of continuous functions.

Unit II: Continuous functions on an interval, intermediate value theorem, location of roots theorem, preservation of intervals theorem. Uniform continuity, non-uniform continuity criteria, uniform continuitytheorem.

Unit III: Differentiability of a function at a point and in an interval, Caratheodory's theorem, algebra of differentiable functions. Relative extrema, interior extremum theorem. Rolle's theorem, Mean value theorem, intermediate value property of derivatives,

Unit IV: Darboux's theorem. Applications of mean value theorem to inequalities and approximation of polynomials, Taylor's theorem to inequalities. Cauchy's mean value theorem.

Unit V: Taylor's theorem with Lagrange's form of remainder, Taylor's theorem with Cauchy's form of remainder, application of Taylor's theorem to convex functions, relative extrema. Taylor's series and Maclaurin's series expansions of exponential and trigonometric functions, $\ln(1 + x)$, $1/(ax+b)$ and $(1 +x)^{n}$.

Books Recommended

1. R. Bartle and D.R. Sherbert, *Introduction to Real Analysis*, John Wiley and Sons, 2003.

2. K.A. Ross, *Elementary Analysis: The Theory of Calculus*, Springer, 2004.

3. A. Mattuck, *Introduction to Analysis*, Prentice Hall, 1999.

4. S.R. Ghorpade and B.V. Limaye, *A Course in Calculus and Real Analysis,* Springer, 2006.

PRACTICAL – MS- WORD
Marks - 25

Mathematics CC VI: Group Theory I
(Credits: Theory-04, Practicals-02)
Full Marks: 75 (Midterm − 15+ End term − 60)
(Unit Wise question pattern- Answer one question from each Unit)

Unit I: Symmetries of a square, Dihedral groups, definition and examples of groups including permutation groups and quaternion groups (illustration through matrices), elementary properties of groups.

Unit II: Subgroups and examples of subgroups, centralizer, normalizer, center of a group, product of two subgroups. Properties of cyclic groups, classification of subgroups of cyclic groups.

Unit III: Cycle notation for permutations, properties of permutations, even and odd permutations, alternating group, properties of cosets, Lagrange's theorem and consequences including Fermat's Little theorem.

Unit IV: External direct product of a finite number of groups, normal subgroups, factor groups, Cauchy's theorem for finite abelian groups.

Unit V: Group homomorphisms, properties of homomorphisms, Cayley's theorem, properties of isomorphisms, First, Second and Third isomorphism theorems.

Books Recommended
1.   John B. Fraleigh, *A First Course in Abstract Algebra*, 7th Ed., Pearson, 2002**.**

2.   M. Artin, *Abstract Algebra*, 2nd Ed., Pearson, 2011.

3.   Joseph A. Gallian, *Contemporary Abstract Algebra,* 4th Ed., Narosa Publishing House, New Delhi, 1999.

4.   Joseph J. Rotman, *An Introduction to the Theory of Groups,* 4th Ed., Springer Verlag, 1995.

5.   I.N. Herstein, *Topics in Algebra*, Wiley Eastern Limited, India, 1975.

Practical - MS- Power Point
Mark- 25

Mathematics CC VII: PDE and Systems of ODE
(Credits: Theory-04, Practicals-02)
Full Marks: 75 (Midterm − 15+ End term − 60)
(Unit Wise question pattern- Answer one question from each Unit)

Unit I: Partial Differential Equations – Basic concepts and Definitions, Mathematical Problems. First- Order Equations: Classification, Construction and Geometrical Interpretation. Method of Characteristics for obtaining General Solution of Quasi Linear Equations. Canonical Forms of First-order Linear Equations.

Unit II: Method of Separation of Variables for solving first order partial differential equations. Derivation of Heat equation, Wave equation and Laplace equation. Classification of second order linear equations as hyperbolic, parabolic or elliptic. Reduction of second order Linear Equations to canonical forms.

Unit III: The Cauchy problem, the Cauchy-Kowaleewskaya theorem, Cauchy problem of an infinite string. Initial Boundary Value Problems, Semi-Infinite String with a fixed end, Equations with non-homogeneous boundary conditions, Non- Homogeneous, Wave Equation. Method of separation of variables, Solving the Vibrating String Problem, Solving the Heat Conduction problem

Unit IV: Systems of linear differential equations, types of linear systems, differential operators, an operator method for linear systems with constant coefficients, Basic Theory of linear systems in normal form

Unit V: Homogeneous linear systems with constant coefficients: Two Equations in two unknown functions, The method of successive approximations, the Euler method, the modified Euler method, The Runge-Kutta method.

List of Practical (using any software)- 25 marks
 (i) Solution of Cauchy problem for first order PDE.
 (ii) Finding the characteristics for the first order PDE.
 (iii) Plot the integral surfaces of a given first order PDE with initial data.

 (iv) Solution of wave equation $\dfrac{\partial^2 u}{\partial t^2} - c\dfrac{\partial^2 u}{\partial x^2} = 0$ for the following associated conditions

 (a) $u(x,0)=\emptyset(x)$, $\quad u_t(x,0)=\Psi(x)$, $\quad x \in R, \ t > 0$

 (b) $u(x,0)=\emptyset(x)$, $\quad u_t(x,0)= \Psi(x)$, $\quad u(0,t) = 0, \ x \in (0,\infty), \ t > 0$

 (c) $u(x,0)=\emptyset(x)$, $\quad u_t(x,0)= \Psi(x)$, $\quad u_x(0,t) = 0, \ x \in (0,\infty), \ t > 0$

 (d) $u(x,0)=\emptyset(x)$, $\quad u_t(x,0)= \Psi(x)$, $\quad u(0,t) = 0, \ u(1,t) = 0, \ 0 < x < l, \ t > 0$

 (v) Solution of wave equation $\dfrac{\partial u}{\partial t} - k\dfrac{\partial^2 u}{\partial x^2} = 0$ for the following associated conditions

 (a) $u(x,0) = \emptyset(x), u(0,t) = a, u(l,t) = b, 0 < x < l, t > 0$
 (b) $u(x,0) = \emptyset(x), \ x \in R, \ 0 < t < T$
 (c) $u(x,0) = \emptyset(x), u(0,t) = a, x \in (0,\infty), t \geq 0$

Books Recommended
1.   Tyn Myint-U and Lokenath Debnath, *Linear Partial Differential Equations for Scientists and Engineers,* 4th edition, Springer, Indian reprint, 2006.
2.   S.L. Ross, *Differential equations,* 3rd Ed., John Wiley and Sons, India, 2004.
3.   Martha L Abell, James P Braselton, *Differential equations with MATHEMATICA,* 3rd Ed.,

SEMESTER – IV

Mathematics SEC II: Graph Theory (for Science & Arts Students)
Full marks 50 (Mid Term 10 + End Term 40)
(Unit wise question pattern, answer one question from each unit)

Unit I: Definition, examples and basic properties of graphs, pseudo graphs,

Unit II: Complete graphs, bi-partite graphs, isomorphism of graphs,

Unit III: Paths and circuits, Eulerian circuits, Hamiltonian cycles,

Unit IV: The adjacency matrix, weighted graph, travelling salesman's problem,

Unit V: Shortest path, Dijkstra's algorithm, Floyd-Warshall algorithm.

Books Recommended

1. B.A. Davey and H.A. Priestley, *Introduction to Lattices and Order*, Cambridge University Press, Cambridge, 1990.

2. Edgar G. Goodaire and Michael M. Parmenter, *Discrete Mathematics with Graph Theory,* 2nd Edition, Pearson Education (Singapore) P. Ltd., Indian Reprint 2003.

3. Rudolf Lidl and Gunter Pilz, Applied Abstract Algebra, 2nd Ed., Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.

Mathematics GE IV: Ring Theory and Linear Algebra I
(Credits: Theory-04, Practicals-02)
Full Marks: 75 (Midterm – 15+ End term – 60)
(Unit Wise question pattern- Answer one question from each Unit)

Unit I: Definition and examples of rings, properties of rings, subrings, integral domains and fields, characteristic of a ring. Ideal, ideal generated by a subset of a ring, factor rings, operations on ideals, prime and maximal ideals.

Unit II: Ring homomorphisms, properties of ring homomorphisms, Isomorphism theorems I, II and III, field of quotients.

Unit III: Vector spaces, subspaces, algebra of subspaces, quotient spaces, linear combination of vectors, linear span, linear independence, basis and dimension, dimension of subspaces.

Unit IV: Linear transformations, null space, range, rank and nullity of a linear transformation, matrix representation of a linear transformation, algebra of linear transformations.

Unit V: Isomorphisms, Isomorphism theorems, invertibility and isomorphisms, change of coordinate matrix.

Books Recommended

1.   John B. Fraleigh, *A First Course in Abstract Algebra*, 7th Ed., Pearson, 2002**.**
2.   M. Artin, *Abstract Algebra*, 2nd Ed., Pearson, 2011.
3.   Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence, *Linear Algebra,* 4th Ed., Prentice- Hall of India Pvt. Ltd., New Delhi, 2004.

4.   Joseph A. Gallian, *Contemporary Abstract Algebra*, 4th Ed., Narosa Publishing House, New Delhi, 1999.

5.   S. Lang, *Introduction to Linear Algebra,* 2nd Ed., Springer, 2005.

6.   Gilbert Strang, *Linear Algebra and its Applications*, Thomson, 2007.

7.   S. Kumaresan, *Linear Algebra- A Geometric Approach*, Prentice Hall of India, 1999.

8.   Kenneth Hoffman, Ray Alden Kunze, *Linear Algebra,* 2nd Ed., Prentice-Hall of India Pvt. Ltd., 1971.

9. D.A.R. Wallace, *Groups, Rings and Fields*, Springer Verlag London Ltd., 1998.

PROJECT PAPER - 25 Marks

Mathematics CC VIII: Numerical Methods
(Credits: Theory-04, Practicals-02)
Full Marks: 75 (Midterm − 15+ End term − 60)
(Unit Wise question pattern- Answer one question from each Unit)

Use of Scientific Calculator is allowed.

Unit I: Algorithms, Convergence, Errors: Relative, Absolute, Round off, Truncation. Transcendental and Polynomial equations: Bisection method, Newton's method, Secant method. Rate of convergence of these methods.

Unit II: System of linear algebraic equations: Gaussian Elimination and Gauss Jordan methods. Gauss Jacobi method, Gauss Seidel method and their convergence analysis.

Unit III: Interpolation: Lagrange and Newton's methods. Error bounds. Finite difference operators. Gregory forward and backward difference interpolation..

Unit IV: Numerical Integration: Trapezoidal rule, Simpson's rule, Simpsons 3/8th rule, Boole's Rule. Midpoint rule, Composite Trapezoidal rule, Composite Simpson's rule.

Unit V: Ordinary Differential Equations: Euler's method. Runge-Kutta methods of orders two and four.

List of Practicals (using any software)
  (i) Calculate the sum $1/1 + 1/2 + 1/3 + 1/4 + ----------+ 1/N$.
  (ii) To find the absolute value of an integer.
  (iii) Enter 100 integers into an array and sort them in an ascending order.
  (iv) Bisection Method.
  (v) Newton Raphson Method.
  (vi) Secant Method.
  (vii) Regulai Falsi Method.
  (viii) LU decomposition Method.
  (ix) Gauss-Jacobi Method.
  (x) SOR Method or Gauss-Siedel Method.
  (xi) Lagrange Interpolation or Newton Interpolation.
  (xii) Simpson's rule.

Note: For any of the CAS (Computer aided software) Data types-simple data types, floating data types, character data types, arithmetic operators and operator precedence, variables and constant declarations, expressions, input/output, relational operators, logical operators and logical expressions, control statements and loop statements, Arrays should be introduced to the students.

Books Recommended
1. Brian Bradie, *A Friendly Introduction to Numerical Analysis*, Pearson Education, India, 2007.

2. M.K. Jain, S.R.K. Iyengar and R.K. Jain, *Numerical Methods for Scientific and Engineering Computation*, 6th Ed., New age International Publisher, India, 2007.

3. C.F. Gerald and P.O. Wheatley, *Applied Numerical Analysis*, Pearson Education, India, 2008.
4. Uri M. Ascher and Chen Greif, *A First Course in Numerical Methods*, 7th Ed., PHI Learning Private Limited, 2013.

5. John H. Mathews and Kurtis D. Fink, *Numerical Methods using Matlab*, 4th Ed., PHI Learning Private Limited, 2012.

Mathematics CC IX: Riemann Integration and Series of Functions
(Credits: Theory-04, Project-02)
Full Marks: 75 (Midterm – 15+ End term – 60)
(Unit Wise question pattern- Answer one question from each Unit)

Unit I: Riemann integration; inequalities of upper and lower sums; Riemann conditions of integrability. Riemann sum and definition of Riemann integral through Riemann sums; equivalence of two definitions;

Unit II: Riemann integrability of monotone and continuous functions, Properties of the Riemann integral; definition and integrability of piecewise continuous and monotone functions. Intermediate Value theorem for Integrals; Fundamental theorems of Calculus.

Unit III: Improper integrals; Convergence of Beta and Gamma functions. Pointwise and uniform convergence of sequence of functions. Theorems on continuity, derivability and integrability of the limit function of a sequence of functions.

Unit IV: Series of functions; Theorems on the continuity and derivability of the sum function of a series of functions; Cauchy criterion for uniform convergence and Weierstrass M-Test.

Unit V: Limit superior and Limit inferior. Power series, radius of convergence, Cauchy Hadamard Theorem, Differentiation and integration of power series; Abel's Theorem; Weierstrass Approximation Theorem.

Books Recommended

1. K.A. Ross, *Elementary Analysis, The Theory of Calculus*, Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.

2. R.G. Bartle D.R. Sherbert, *Introduction to Real Analysis,* 3rd Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2002.

3. Charles G. Denlinger, *Elements of Real Analysis*, Jones & Bartlett (Student Edition), 2011.

PROJECT PAPER - 25 Marks

Mathematics CC X: Ring Theory and Linear Algebra I
(Credits: Theory-04, Project-02)
Full Marks: 75 (Midterm − 15+ End term − 60)
(Unit Wise question pattern- Answer one question from each Unit)

Unit I: Definition and examples of rings, properties of rings, subrings, integral domains and fields, characteristic of a ring. Ideal, ideal generated by a subset of a ring, factor rings, operations on ideals, prime and maximal ideals.

Unit II: Ring homomorphisms, properties of ring homomorphisms, Isomorphism theorems I, II and III, field of quotients.

Unit III: Vector spaces, subspaces, algebra of subspaces, quotient spaces, linear combination of vectors, linear span, linear independence, basis and dimension, dimension of subspaces.

Unit IV: Linear transformations, null space, range, rank and nullity of a linear transformation, matrix representation of a linear transformation, algebra of linear transformations.

Unit V: Isomorphisms, Isomorphism theorems, invertibility and isomorphisms, change of coordinate matrix.

Books Recommended

1. John B. Fraleigh, *A First Course in Abstract Algebra*, 7th Ed., Pearson, 2002**.**

2. M. Artin, *Abstract Algebra*, 2nd Ed., Pearson, 2011.

3. Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence, *Linear Algebra,* 4th Ed., Prentice- Hall of India Pvt. Ltd., New Delhi, 2004.

4. Joseph A. Gallian, *Contemporary Abstract Algebra*, 4th Ed., Narosa Publishing House, New Delhi, 1999.

5. S. Lang, *Introduction to Linear Algebra,* 2nd Ed., Springer, 2005.

6. Gilbert Strang, *Linear Algebra and its Applications*, Thomson, 2007.

7. S. Kumaresan, *Linear Algebra- A Geometric Approach*, Prentice Hall of India,1999.

8. Kenneth Hoffman, Ray Alden Kunze, *Linear Algebra,* 2nd Ed., Prentice-Hall of India Pvt. Ltd., 1971.

9. D.A.R. Wallace, *Groups, Rings and Fields*, Springer Verlag London Ltd., 1998.

PROJECT PAPER - 25 Marks

SEMESTER - V

Mathematics DSE I: Number Theory
(Credits: Theory-04, Project-02)
Full Marks: 75 (Midterm − 15+ End term − 60)
(Unit Wise question pattern- Answer one question from each Unit)

Unit I: Linear Diophantine equation, prime counting function, statement of prime number theorem, Goldbach conjecture, linear congruences, complete set of residues, Chinese Remainder theorem,

Unit II: Fermat's Little theorem, Wilson's theorem. Number theoretic functions, sum and number of divisors,

Unit III: totally multiplicative functions, definition and properties of the Dirichlet product, the Mobius Inversion formula, the greatest integer function,

Unit IV: Euler's phi-function, Euler's theorem, reduced set of residues, some properties of Euler's phi-function. Order of an integer modulo n, primitive roots for primes, composite numbers having primitive roots,

Unit V: Euler's criterion, the Legendre symbol and its properties, quadratic reciprocity, quadratic congruences with composite moduli. Public key encryption, RSA encryption and decryption, the equation $x^2 + y^2 = z^2$, Fermat's Last theorem.

Books Recommended

1. David M. Burton, *Elementary Number Theory,* 6th Ed., Tata McGraw-Hill, Indian reprint, 2007.

2. Neville Robinns, *Beginning Number Theory,* 2nd Ed., Narosa Publishing House Pvt. Ltd., Delhi, 2007.

Project Paper - 25 Marks

Mathematics DSE II: Probability and Statistics
(Credits: Theory-04, Project-02)
Full Marks: 75 (Midterm – 15+ End term – 60)
(Unit Wise question pattern- Answer one question from each Unit)

Unit I: Sample space, probability axioms, real random variables (discrete and continuous), cumulative distribution function, probability mass/density functions, mathematical expectation, moments, moment generating function, characteristic function,

Unit II: Discrete distributions: uniform, binomial, Poisson, geometric, negative binomial, continuous distributions: uniform, normal, exponential.

Unit III: Joint cumulative distribution function and its properties, joint probability density functions, marginal and conditional distributions, expectation of function of two random variables, conditional expectations,

Unit IV: independent random variables, bivariate normal distribution, correlation coefficient, joint moment generating function (jmgf) and calculation of covariance (from jmgf), linear regression for two variables.

Unit V: Chebyshev's inequality, statement and interpretation of (weak) law of large numbers and strong law of large numbers, Central Limit theorem for independent and identically distributed random variables with finite variance, Markov Chains, Chapman-Kolmogorov equations, classification of states.

Books Recommended

1. Robert V. Hogg, Joseph W. McKean and Allen T. Craig, *Introduction to Mathematical Statistics*, Pearson Education, Asia, 2007.

2. Irwin Miller and Marylees Miller, John E. Freund, *Mathematical Statistics with Applications*, 7th Ed., Pearson Education, Asia, 2006.

3. Sheldon Ross, *Introduction to Probability Models,* 9th Ed., Academic Press, Indian Reprint, 2007.

4. Alexander M. Mood, Franklin A. Graybill and Duane C. Boes, *Introduction to the Theory of Statistics*, 3rd Ed., Tata McGraw- Hill, Reprint 2007

PROJECT PAPER - 25 Marks

Mathematics CC XI: Multivariate Calculus
(Credits: Theory-04, Project-02)
Full Marks: 75 (Midterm – 15+ End term – 60)
(Unit Wise question pattern- Answer one question from each Unit)

Use of Scientific calculator is allowed.

Unit I: Functions of several variables, limit and continuity of functions of two variables Partial differentiation, total differentiability and differentiability, sufficient condition for differentiability. Chain rule for one and two independent parameters,

Unit II: directional derivatives, the gradient, maximal and normal property of the gradient, tangent planes, Extrema of functions of two variables, method of Lagrange multipliers, constrained optimization problems, Definition of vector field, divergence and curl.

Unit III: Double integration over rectangular region, double integration over non-rectangular region, Double integrals in polar co-ordinates, Triple integrals, Triple integral over a parallelepiped and solid regions. Volume by triple integrals, cylindrical and spherical co-ordinates.

Unit IV: Change of variables in double integrals and triple integrals. Line integrals, Applications of line integrals: Mass and Work. Fundamental theorem for line integrals, conservative vector fields, independence of path.

Unit V: Green's theorem, surface integrals, integrals over parametrically defined surfaces. Stoke's theorem, The Divergence theorem.

Books Recommended

1. G.B. Thomas and R.L. Finney, *Calculus*, 9th Ed., Pearson Education, Delhi, 2005.

2. M.J. Strauss, G.L. Bradley and K. J. Smith, *Calculus,* 3rd Ed., Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), Delhi, 2007.

3. E. Marsden, A.J. Tromba and A. Weinstein, *Basic Multivariable Calculus*, Springer (SIE), Indian reprint, 2005.

4. James Stewart, *Multivariable Calculus, Concepts and Contexts*, 2nd Ed., Brooks /Cole, Thomson Learning, USA, 2001.

PROJECT PAPER - 25 Marks

Mathematics CC XII: Group Theory II
(Credits: Theory-04, Practicals-02)
Full Marks: 75 (Midterm − 15+ End term − 60)
(Unit Wise question pattern- Answer one question from each Unit)

Unit I: Automorphism, inner automorphism, automorphism groups, automorphism groups of finite and infinite cyclic groups, applications of factor groups to automorphism groups,

Unit II: Characteristic subgroups, Commutator subgroup and its properties. Properties of external direct products, the group of units modulo n as an external direct product, internal direct products,

Unit III: Fundamental Theorem of finite abelian groups. Group actions, stabilizers and kernels, permutation representation associated with a given group action,

Unit IV: Applications of group actions: Generalized Cayley's theorem, Index theorem. Groups acting on themselves by conjugation, class equation and consequences, conjugacy in S_n, *p*-groups,

Unit V: Sylow's theorems and consequences, Cauchy's theorem, Simplicity of A_n for $n \geq 5$, non-simplicity tests.

Books Recommended

1. John B. Fraleigh, *A First Course in Abstract Algebra*, 7th Ed., Pearson, 2002.

2. M. Artin, *Abstract Algebra*, 2nd Ed., Pearson, 2011.

3. Joseph A. Gallian, *Contemporary Abstract Algebra,* 4th Ed., Narosa Publishing House, 1999.

4. David S. Dummit and Richard M. Foote, *Abstract Algebra*, 3rd Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2004.

5. J.R. Durbin, *Modern Algebra*, John Wiley & Sons, New York Inc., 2000.

6. D. A. R. Wallace, *Groups, Rings and Fields*, Springer Verlag London Ltd., 1998.

PROJECT PAPER - 25 Marks

Mathematics DSE III: Linear Programming
(Credits: Theory-04, Project-02)
Full Marks: 75 (Midterm − 15+ End term − 60)
(Unit Wise question pattern- Answer one question from each Unit)

Unit I: Introduction to linear programming problem, Theory of simplex method, optimality and unboundedness, the simplex algorithm, simplex method in tableau format, introduction to artificial variables, two-phase method, Big-M method and their comparison.

Unit II: Duality, formulation of the dual problem, primal-dual relationships, economic interpretation of the dual.

Unit III: Transportation problem and its mathematical formulation, northwest-corner method least cost method and Vogel approximation method for determination of starting basic solution, algorithm for solving transportation problem,

Unit IV: Assignment problem and its mathematical formulation, Hungarian method for solving assignment problem.

Unit V: Game theory: formulation of two person zero sum games, solving two person zero sum games, games with mixed strategies, graphical solution procedure, linear programming solution of games.

Books Recommended

1. Mokhtar S. Bazaraa, John J. Jarvis and Hanif D. Sherali, *Linear Programming and Network Flows,* 2nd Ed., John Wiley and Sons, India, 2004.

2. F.S. Hillier and G.J. Lieberman, *Introduction to Operations Research,* 9th Ed., Tata McGraw Hill, Singapore, 2009.

3. Hamdy A. Taha, *Operations Research, An Introduction,* 8th Ed., Prentice-Hall India, 2006.

4. G. Hadley, *Linear Programming*, Narosa Publishing House, New Delhi, 2002.

PROJECT PAPER - 25 Marks

Mathematics DSE IV:
PROJECT WORK / DISSERTATION
Full Marks - 100

Mathematics CC XIII: Metric Spaces and Complex Analysis
(Credits: Theory-04, Project-02)
Full Marks: 75 (Midterm – 15+ End term – 60)
(Unit Wise question pattern- Answer one question from each Unit)

Unit I: Metric spaces: definition and examples. Sequences in metric spaces, Cauchy sequences. Complete Metric Spaces. Open and closed balls, neighbourhood, open set, interior of a set. Limit point of a set, closed set, diameter of a set, Cantor's theorem. Subspaces, dense sets, separable spaces.

Unit II: Continuous mappings, sequential criterion and other characterizations of continuity. Uniform continuity. Homeomorphism, Contraction mappings, Banach Fixed point Theorem. Connectedness, connected subsets of R.

Unit III: Limits, Limits involving the point at infinity, continuity. Properties of complex numbers, regions in the complex plane, functions of complex variable, mappings. Derivatives, differentiation formulas, Cauchy-Riemann equations, sufficient conditions for differentiability.

Unit IV: Analytic functions, examples of analytic functions, exponential function, Logarithmic function, trigonometric function, derivatives of functions, definite integrals of functions. Contours, Contour integrals and its examples, upper bounds for moduli of contour integrals. Cauchy- Goursat theorem, Cauchy integral formula.

Unit V: Liouville's theorem and the fundamental theorem of algebra. Convergence of sequences and series, Taylor series and its examples.

Laurent series and its examples, absolute and uniform convergence of power series.

Books Recommended

1. Satish Shirali and Harikishan L. Vasudeva, *Metric Spaces*, Springer Verlag, London, 2006.

2. S. Kumaresan, *Topology of Metric Spaces*, 2nd Ed., Narosa Publishing House, 2011.

3. G.F. Simmons, *Introduction to Topology and Modern Analysis*, McGraw-Hill, 2004.

4. James Ward Brown and Ruel V. Churchill, *Complex Variables and Applications,* 8th Ed., McGraw – Hill International Edition, 2009.

5. Joseph Bak and Donald J. Newman, *Complex Analysis,* 2nd Ed., Undergraduate Texts in Mathematics, Springer-Verlag New York, Inc., New York, 1997.

PROJECT PAPER

Mathematics CC XIV: Ring Theory and Linear Algebra II
(Credits: Theory-04, Practicals-02)
Full Marks: 75 (Midterm – 15+ End term – 60)
(Unit Wise question pattern- Answer one question from each Unit)

Unit I: Polynomial rings over commutative rings, division algorithm and consequences, principal ideal domains, factorization of polynomials, reducibility tests, irreducibility tests, Eisenstein criterion.

Unit II: Unique factorization in Z[x]**.** Divisibility in integral domains, irreducibles, primes, unique factorization domains, Euclidean domains.

Unit III: Dual spaces, dual basis, double dual, transpose of a linear transformation and its matrix in the dual basis, annihilators, Eigen spaces of a linear operator, diagonalizability, invariant subspaces and Cayley-Hamilton theorem, the minimal polynomial for a linear operator.

Unit IV: Inner product spaces and norms, Gram-Schmidt orthogonalisation process, orthogonal complements, Bessel's inequality, the adjoint of a linear operator, Least Squares Approximation,

Unit V: Minimal solutions to systems of linear equations, Normal and self-adjoint operators, Orthogonal projections and Spectral theorem.

Books Recommended

1. John B. Fraleigh, *A First Course in Abstract Algebra*, 7th Ed., Pearson, 2002**.**

2. M. Artin, *Abstract Algebra*, 2nd Ed., Pearson, 2011.

3. Joseph A. Gallian, *Contemporary Abstract Algebra*, 4th Ed., Narosa Publishing House, 1999.

4. Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence, *Linear Algebra,* 4th Ed., Prentice- Hall of India Pvt. Ltd., New Delhi, 2004.

5. S. Lang, *Introduction to Linear Algebra,* 2nd Ed., Springer, 2005.

6. Gilbert Strang, *Linear Algebra and its Applications*, Thomson, 2007.

5. S. Kumaresan, *Linear Algebra- A Geometric Approach*, Prentice Hall of India, 1999.

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PROJECT PAPER - 25 Marks