

Choice Based Credit System (CBCS)

Gangadhar Meher University

SAMBALPUR, ODISHA

UNDERGRADUATE PROGRAMME IN STATISTICS
(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 STATISTICS

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 will 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 CGPA

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.

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

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.

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

Where S_i is the SGPA of the i st. 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= $\frac{20 \times 6.9 + 22 \times 7.8 + 25 \times 5.6 + 26 \times 6.0 + 26 \times 6.3 + 25 \times 8.0}{144}$					=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
$\geq 8.5 - < 9.5$	A+	Excellent	$\geq 80 - < 90$	
$\geq 7.5 - < 8.5$	A	Very good	$\geq 70 - < 80$	
$\geq 6.5 - < 7.5$	B+	Good	$\geq 60 - < 70$	
$\geq 5.5 - < 6.5$	B	Above average	$\geq 50 - < 60$	Second Class Honours
$\geq 5.0 - < 5.5$	C	Average	$\geq 45 - < 50$	Pass without Honours
$\geq 4.5 - < 5.0$	P	Pass	$\geq 40 - < 45$	
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 be 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
Honours Statistics (Arts & Science)**

Semester		CORE COURSE (14)	Ability Enhancement Compulsory Course (AECC) (2)	Skill Enhancement Elective Course (SEEC) (2)	Elective: Discipline Specific DSE (4)	Elective: Generic (GE) (4)
I	CC1	Descriptive Statistics	AECC-I Environmental Studies			GE-I Statistical Methods
	CCII	Calculus				
II	CCIII	Probability and Probability Distributions	AECC-II English Communication/ Odia/ Hindi			GE-II Introductory Probability
	CCIV	Algebra				
III	CCV	Sampling Distributions		SEC-I Communicative English and English Writing		GE-III Introduction to Operation Research
	CCVI	Survey Sampling & Indian Official Statistics				
	CCVII	Mathematical Analysis				
IV	CCVIII	Statistical Inference		SEC-II Statistical Techniques for Research Methods		GE-IV Applied Statistics
	CCIX	Linear Models				
	CCX	Statistical Quality Control				
V	CCXI	Stochastic Process & Queuing Theory			DSE-I Operation Research	
	CCXII	Statistical Computing Using C/C++ Programming			DSE-II Time Series Analysis	
VI	CCXIII	Design of Experiments			DSE-III Demography and Vital Statistics	
	CC XIV	Multivariate Analysis and Nonparametric Methods			DSE-IV Project Work / Dissertation	

Course Structure for B. Sc. Statistics Honours

Semester	Course Name	Course Offered	Title Of Paper	Credits	Marks
I 4 Papers 350 marks 20 Credits	AECC	Ability Enhancement Compulsory Course-I	Environmental Science	2	50 (10+40)
	Generic Elective	Generic Elective -1	Statistical Methods	4	75 (15+60)
		Generic Elective -1 Practical	Practical	2	25
	Core Course	Core Course-I	Descriptive Statistics	4	75 (15+60)
		Core Course-I Practical	Practical	2	25
		Core Course-II	Calculus	4	75 (15+60)
		Core Course-II Practical	Practical	2	25
II 4 Papers 350 marks 20 Credits	AECC	Ability Enhancement Compulsory Course II	English Communications / Odia / Hindi	2	50 (10+40)
	Generic Elective	Generic Elective -II	Introductory Probability	4	75 (15+60)
		Generic Elective -II Practical	Practical	2	25
	Core Course	Core Course-III	Probability and Probability Distributions	4	75 (15+60)
		Practical Core Course-III	Practical	2	25
		Core Course-IV	Applied Statistics	4	75 (15+60)
		Core Course-IV Practical	Practical	2	25
III 5 paper 450 Marks 26 Credits	SEC	Skill Enhancement Course -I	Communicative English and English Writing	2	50 (10+40)
	Generic Elective	Generic Elective - III	Introduction to Operation Research	4	75 (15+60)
		Generic Elective -III Practical	Practical	2	25
	Core Course	Core Course-V	Sampling Distributions	4	75 (15+60)
		Core Course-V Practical	Practical	2	25
		Core Course-VI	Survey Sampling & Indian Official Statistics	4	75 (15+60)
		Core Course-VI Practical	Practical	2	25
		Core Course-VII	Mathematical Analysis	4	75 (15+60)
Core Course-VII Practical		Practical	2	25	
IV 5 Papers 450 Marks 26 Credits	SEC	Skill Enhancement Course -II	Statistical Techniques for Research Methods	2	50(10+40)
	Generic Elective	Generic Elective - IV	Applied Statistics	4	75 (15+60)
		Generic Elective -4 Practical	Practical	2	25
	Core Course	Core Course-VIII	Statistical Inference	4	75 (15+60)
		Core Course-VIII Practical	Practical	2	25
		Core Course-IX	Linear Models	4	75 (15+60)
		Core Course-IX Practical	Practical	2	25
		Core Course-X	Statistical Quality Control	4	75 (15+60)
Course-X Practical		Practical	2	25	

Semester	Course Name	Course Offered	Title Of Paper	Credits	Marks
V 4 Paper 400 marks 24 credits	DSE	Discipline Specific Elective I	Operation Research	4	75 (15+60)
		Discipline Specific Elective -I	Practical	2	25
		Discipline Specific Elective -II	Time Series Analysis	4	75 (15+60)
		Discipline Specific Elective- II	Practical	2	25
	Core Course	Core Course-XI	Stochastical Process & Queuing Theory	4	75 (15+60)
		Core Course-XI Practical	Practical	2	25
		Core Course-XII	Statistical Computing Using C/C++Programming	4	75 (15+60)
		Core Course-XII Practical	Practical	2	25
VI 4 paper 400 marks 24 credits	DSE	Discipline Specific Elective -III	Demography and Vital Statistics	4	75 (15+60)
		Discipline Specific Elective - III Practical	Practical	2	25
		Discipline Specific Elective- IV	Dissertation / Project work	6	100
	Core Course	Core Course-XIII	Design of Experiments	4	75 (15+60)
		Core Course-XIII Practical	Practical	2	25
		Core Course-XIV	Multivariate Analysis and Nonparametric Methods	4	75 (15+60)
		Core Course-XIV Practical	Practical	2	25
Total				140	2400

SEMESTER – I

Ability Enhancement Compulsory Course (AECC- I): Environment Studies

Full marks 50 (Mid Term 10 + End Term 40)

(Unit wise question pattern, answer one question from each unit)

Unit 1 : Introduction to environmental studies

- Multidisciplinary nature of environmental studies;
- Scope and importance; Concept of sustainability and sustainable development.

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 land use 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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6. Grumbine, R. Edward, and Pandit, M.K. 2013. Threats from India's Himalaya dams. *Science*, 339: 36-37.
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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.

Statistics GE I: Statistical Methods
(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: Introduction: Definition and scope of Statistics, concepts of statistical population and sample. Data: quantitative and qualitative, attributes, variables, scales of measurement - nominal, ordinal, interval and ratio. Presentation: tabular and graphic, including histogram and ogives.

Unit II: Measures of Central Tendency: mathematical and positional. Measures of Dispersion: range, quartile deviation, mean deviation, standard deviation, coefficient of variation,

Unit III: Moments, skewness and kurtosis. Principle of least squares and fitting of polynomials and exponential curves.

Unit IV: Bivariate data: Definition, scatter diagram, simple, partial and multiple correlation (3 variables only), rank correlation. Simple linear regression,

Unit V: Theory of attributes, consistency of data, independence and association of attributes, measures of association and contingency.

SUGGESTED READING:

1. Goon A.M., Gupta M.K. and Dasgupta B. (2002): Fundamentals of Statistics, Vol. I & II, 8th Edn. The World Press, Kolkata.
2. Miller, Irwin and Miller, Marylees (2006): John E. Freund's Mathematical Statistics with Applications, (7th Edn.), Pearson Education, Asia.
3. Mood, A.M. Graybill, F.A. and Boes, D.C. (2007): Introduction to the Theory of Statistics, 3rd Edn., (Reprint), Tata McGraw-Hill Pub. Co. Ltd.

Generic Elective I Lab: Statistics
Credits – 2, Full Marks – 25,

1. Graphical representation of data
2. Problems based on measures of central tendency
3. Problems based on measures of dispersion
4. Problems based on combined mean and variance and coefficient of variation
5. Problems based on moments, skewness and kurtosis
6. Fitting of polynomials, exponential curves
7. Karl Pearson correlation coefficient
8. Partial and multiple correlations
9. Spearman rank correlation with and without ties.
10. Correlation coefficient for a bivariate frequency distribution
11. Lines of regression, angle between lines and estimated values of variables.
12. Checking consistency of data and finding association among attributes.

Statistics CC I: Descriptive Statistics

(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: Statistical Methods: Definition and scope of Statistics, concepts of statistical population and sample. Data: quantitative and qualitative, attributes, variables, scales of measurement- nominal, ordinal, interval and ratio. Presentation: tabular and graphical, including histogram and ogives, consistency and independence of data with special reference to attributes.

Unit II: Measures of Central Tendency: mathematical and positional. Measures of Dispersion: range, quartile deviation, mean deviation, standard deviation, coefficient of variation,

Unit III: Moments, absolute moments, factorial moments, skewness and kurtosis, Sheppard's corrections. Principle of least squares and fitting of polynomials and exponential curves.

Unit IV: Bivariate data: Definition, scatter diagram, simple, partial and multiple correlation (3 variables only), rank correlation. Simple linear regression,

Unit V: Index Numbers: Definition, construction of index numbers and problems thereof for weighted and unweighted index numbers including Laspeyre's, Paasche's, Edgeworth-Marshall and Fisher's. Chain index numbers, conversion of fixed based to chain based index numbers and vice-versa. Consumer price index numbers.

SUGGESTED READING:

1. Goon A.M., Gupta M.K. and Dasgupta B. (2002): Fundamentals of Statistics, Vol. I & II, 8th Edn. The World Press, Kolkata.
2. Miller, Irwin and Miller, Marylees (2006): John E. Freund's Mathematical Statistics with Applications, (7th Edn.), Pearson Education, Asia.
3. Mood, A.M. Graybill, F.A. and Boes, D.C. (2007): Introduction to the Theory of Statistics, 3rd Edn., (Reprint), Tata McGraw-Hill Pub. Co. Ltd.

CC I- LAB: STATISTICS

Credits – 2 , Full Marks – 25,

List of Practical

1. Graphical representation of data.
2. Problems based on measures of central tendency.
3. Problems based on measures of dispersion.
4. Problems based on combined mean and variance and coefficient of variation.
5. Problems based on moments, skewness and kurtosis.
6. Fitting of polynomials, exponential curves.
7. Karl Pearson correlation coefficient.
8. Correlation coefficient for a bivariate frequency distribution.
9. Lines of regression, angle between lines and estimated values of variables.
10. Spearman rank correlation with and without ties.
11. Partial and multiple correlations.
12. Planes of regression and variances of residuals for given simple correlations.
13. Planes of regression and variances of residuals for raw data.
14. Calculate price and quantity index numbers using simple and weighted average of price relatives.
15. To calculate the Chain Base index numbers.
16. To calculate consumer price index number.

Statistics CC II: 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: Differential Calculus: Limits of function, continuous functions, properties of continuous functions, partial differentiation and total differentiation. Indeterminate forms: L-Hospital's rule, Leibnitz rule for successive differentiation. Euler's theorem on homogeneous functions. Maxima and minima of functions of one and two variables, constrained optimization techniques (with Lagrange multiplier) along with some problems. Jacobian, concavity and convexity, points of inflexion of function, singular points.

Unit II: Integral Calculus: Review of integration and definite integral. Differentiation under integral sign, double integral, change of order of integration, transformation of variables. Beta and Gamma functions: properties and relationship between them.

Unit III: Differential Equations: Exact differential equations, Integrating factors, change of variables, Total differential equations, Differential equations of first order and first degree, Differential equations of first order but not of first degree, Equations solvable for x, y, q, Equations of the first degree in x and y, Clairaut's equations.

Unit IV: Higher Order Differential Equations: Linear differential equations of order n, Homogeneous and non-homogeneous linear differential equations of order n with constant coefficients, Different forms of particular integrals, Linear differential equations with non-constant coefficients, Reduction of order method, The Cauchy-Euler's equation of order n, Legendre's linear equation.

Unit V: Formation and solution of a partial differential equations. Equations easily integrable. Linear partial differential equations of first order. Non-linear partial differential equation of first order and their different forms. Charpit's method. Homogeneous linear partial differential equations with constant coefficients. Different cases for complimentary functions and particular integrals. Non-homogeneous partial differential equations with constant coefficients. Classification of second order linear partial differential equations.

SUGGESTED READINGS:

1. Gorakh Prasad: Differential Calculus, Pothishala Pvt. Ltd., Allahabad (14th Edition - 1997).
2. Gorakh Prasad: Integral Calculus, Pothishala Pvt. Ltd., Allahabad (14th Edition -2000).
3. Zafar Ahsan: Differential Equations and their Applications, Prentice-Hall of India Pvt. Ltd., New Delhi (2nd Edition -2004).
4. Piskunov, N: Differential and Integral Calculus, Peace Publishers, Moscow.

Practical

Credits – 2 , Full Marks – 25,

1. Properties of continuous functions.
2. Applications of Maxima & Minima of functions of one and two variable and constrained optimization techniques (with Lagrange multiplier)
3. Applications of Concavity & Convexity of functions.
4. Applications of Integration
5. Applications of differential equations.
6. Applications of partial differential equations.

SEMESTER II

Ability Enhancement Compulsory Course (AECC -II): English Communication **Credits – 2, 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 (Dilip Chitre)

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
Credits – 2, 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 ଶଗଡ଼ - ଗୋଦାବରୀଶ ମହାପାତ୍ର

ଗୋପପୁର - ରାମଚନ୍ଦ୍ର ବେହେରା

ତୃତୀୟ ଏକକ : ପ୍ରବନ୍ଧ : ଜନ୍ମଭୂମି - କୃଷ୍ଣଚନ୍ଦ୍ର ପାଣିଗ୍ରାହୀ

ଆଧୁନିକ - ହରେକୃଷ୍ଣ ମହତାବ

ଚତୁର୍ଥ ଏକକ : ପ୍ରବନ୍ଧ ରଚନା, ପତ୍ରଲିଖନ, ସମ୍ବାଦଲିଖନ

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

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

ବିଶ୍ୱବିଦ୍ୟାଳୟସ୍ତରୀୟ ମୁଖ୍ୟ ପରୀକ୍ଷାରେ ନିମ୍ନମତେ ପ୍ରଶ୍ନ ପଡ଼ିବ:

ପ୍ରଥମ ଏକକରୁ ଚତୁର୍ଥ ଏକକ ପର୍ଯ୍ୟନ୍ତ ପ୍ରତ୍ୟେକ ଏକକରୁ ୨ଟି ଲେଖାଏଁ ପ୍ରଶ୍ନ ପଡ଼ିବ। ବିଦ୍ୟାର୍ଥୀ ପ୍ରତ୍ୟେକ

ଏକକରୁ ଗୋଟିଏ ଲେଖାଏଁ ପ୍ରଶ୍ନ ର ଉତ୍ତର ଦେବେ । (୪ x ୮ = ୩୨)

ପଞ୍ଚମ ଏକକରୁ ୧୫ ଟି ଅତି ସଂକ୍ଷିପ୍ତ ପ୍ରଶ୍ନ ପଡ଼ିବ । ବିଦ୍ୟାର୍ଥୀ ନିର୍ଦ୍ଦେଶ ଅନୁଯାୟୀ ୮ ଟି ପ୍ରଶ୍ନର ଉତ୍ତର ଦେବେ ।

(୮x୧=୮)

ଗ୍ରନ୍ଥ ସୂଚୀ

୧. କବିତାଗ୍ରୀ - ସଂ. - କୃଷ୍ଣଚରଣ ବେହେରା

୨. ଗଳ୍ପ ଦିଗନ୍ତ - ସଂ. - ସୁରେନ୍ଦ୍ର ନାଥ ଦାସ

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

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

୫. ସାରସ୍ୱତ ପ୍ରବନ୍ଧ ପତ୍ରମାଳା -

୬. ବିଶ୍ୱବିଦ୍ୟାଳୟ ପ୍ରବନ୍ଧମାଳା - ପ୍ର. କୃଷ୍ଣଚନ୍ଦ୍ର ପ୍ରଧାନ

୭. ସର୍ବସାର ବ୍ୟାକରଣ - ଶ୍ରୀଧର ଦାସ ଓ ନାରାୟଣ ମହାପାତ୍ର

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

Ability Enhancement Compulsory Course (AECC - II): HINDI

Credits – 2, Full marks 50 (Mid Term 10 + End Term 40)
(Unit wise question pattern, answer one question from each unit)

हिन्दी भाषा, ब्याकरण एवं रचना

Unit I: हिन्दी के विविध रूप

- (क) राजभाषा, संचारभाषा (श्रव्या माध्यम - दृश्य) (8)
- (ख) सरकारी पत्र लेखन (ब्याबहरिक पक्ष) नमूना (8)

Unit II: अपठित गद्यांश (8)

Unit III: अशुद्धि लेखन

- (क) शब्द शुद्धिकरण (4)
- (ख) वाक्य शुद्धिकरण (4)

Unit IV: शब्द ज्ञान

- (क) पर्याय वाची (4)
- (ख) अनेक शब्द के लिए एक शब्द (4)

Unit V: प्रशासनिक शब्दावली

- (क) अँग्रेजी से हिन्दी (4)
- (ख) हिन्दी से अँग्रेजी (4)

Unit I: यूनिट एक (क) विभाग से एक प्रश्न एवं (ख) विभाग से एक प्रश्न पूछे जाएंगे ।
एक का उत्तर लिखना होगा । (8)

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

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

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

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

Statistics GE II: Introductory Probability
(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: Probability: Introduction, random experiments, sample space, events and algebra of events. Definitions of Probability – classical, statistical, and axiomatic. Conditional Probability, laws of addition and multiplication, independent events, theorem of total probability, Bayes' theorem and its applications.

Unit II: Random Variables: Discrete and continuous random variables, p.m.f., p.d.f., c.d.f. Illustrations of random variables and its properties. Expectation, variance, moments and moment generating function.

Unit III: Convergence in probability, almost sure convergence, Chebyshev's inequality, weak law of large numbers, De-Moivre Laplace and Lindeberg-Levy Central Limit Theorem (C.L.T.).

Unit IV

Standard probability distributions: Binomial, Poisson, geometric, negative binomial,

Unit V: Hypergeometric, uniform, normal, exponential, beta, gamma.

Suggested Reading:

1. Hogg, R.V., Tanis, E.A. and Rao J.M. (2009): Probability and Statistical Inference, Seventh Ed, Pearson Education, New Delhi.
2. Miller, Irwin and Miller, Marylees (2006): John E. Freund's Mathematical Statistics with Applications, (7th Edn.), Pearson Education, Asia.
3. Myer, P.L. (1970): Introductory Probability and Statistical Applications, Oxford & IBH Publishing, New Delhi

GE II- LAB: STATISTICS
Credits – 2, Full Marks – 25,

1. Fitting of binomial distributions for n and $p = q = \frac{1}{2}$ given
2. Fitting of binomial distributions for n and p given
3. Fitting of binomial distributions computing mean and variance
4. Fitting of Poisson distributions for given value of λ
5. Fitting of Poisson distributions after computing mean
6. Application problems based on binomial distribution
7. Application problems based on Poisson distribution
8. Problems based on area property of normal distribution
9. To find the ordinate for a given area for normal distribution
10. Application based problems using normal distribution
11. Fitting of normal distribution when parameters are given

Statistics CC III: Probability and Probability Distributions

(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: Probability: Introduction, random experiments, sample space, events and algebra of events. Definitions of Probability – classical, statistical, and axiomatic. Conditional Probability, laws of addition and multiplication, independent events, theorem of total probability, Bayes' theorem and its applications.

Unit II: Random variables: discrete and continuous random variables, p.m.f., p.d.f. and c.d.f., illustrations and properties of random variables, univariate transformations with illustrations. Two dimensional random variables: discrete and continuous type, joint, marginal and conditional p.m.f, p.d.f., and c.d.f., independence of variables, bivariate transformations with illustrations.

Unit III:

Mathematical Expectation and Generating Functions: Expectation of single and bivariate random variables and its properties. Moments and Cumulants, moment generating function, cumulant generating function and characteristic function. Uniqueness and inversion theorems (without proof) along with applications. Conditional expectations.

Unit IV: Standard probability distributions: Binomial, Poisson, geometric, negative binomial, hypergeometric, uniform, normal,

Unit V: Exponential, Cauchy, beta and gamma along with their properties and limiting / approximation cases.

Suggested Reading:

1. Hogg, R.V., Tanis, E.A. and Rao J.M. (2009): Probability and Statistical Inference, Seventh Ed, Pearson Education, New Delhi.
2. Miller, Irwin and Miller, Marylees (2006): John E. Freund's Mathematical Statistics with Applications, (7th Edn.), Pearson Education, Asia.
3. Myer, P.L. (1970): Introductory Probability and Statistical Applications, Oxford & IBH Publishing, New Delhi

CC III- LAB: STATISTICS

Credits – 2, Full Marks – 25,

1. Fitting of binomial distributions for n and $p = q = \frac{1}{2}$.
2. Fitting of binomial distributions for given n and p .
3. Fitting of suitable distribution.
4. Application problems based on binominal distribution
5. Application problems based on Poisson distribution
6. Application problems based on negative binomial
7. Application problems based on negative binomial distribution.
8. Problems based on area property of normal distribution.
9. To find the ordinate for a given area for normal distribution.
10. Application based problems using normal distribution.
11. Fitting of normal distribution when parameters are given.
12. Fitting of normal distribution when parameters are not given.

Statistics CC IV: 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: Theory of equations, statement of the fundamental theorem of algebra and its consequences. Relation between roots and coefficients or any polynomial equations. Solutions of cubic and biquadratic equations when some conditions on roots of equations are given. Evaluation of the symmetric polynomials and roots of cubic and biquadratic equations. Vector spaces, Subspaces, sum of subspaces, Span of a set, Linear dependence and independence, dimension and basis, dimension theorem.

Unit II: Algebra of matrices - A review, theorems related to triangular, symmetric and skew symmetric matrices, idempotent matrices, Hermitian and skew Hermitian matrices, orthogonal matrices, singular and non-singular matrices and their properties. Trace of a matrix, Unitary, involutory and nilpotent matrices. Adjoint and inverse of a matrix and related properties.

Unit III: Determinants of Matrices: Definition, properties and applications of determinants for 3rd and higher orders, evaluation of determinants of order 3 and more using transformations. Symmetric and Skew symmetric determinants, Circulant determinants and Vandermonde determinants for nth order, Jacobi's Theorem, product of determinants. Use of determinants in solution to the system of linear equations, row reduction and echelon forms, the matrix equations $AX=B$, solution sets of linear equations, linear independence, Applications of linear equations, inverse of a matrix.

Unit IV: Rank of a matrix, row-rank, column-rank, standard theorems on ranks, rank of the sum and the product of two matrices. Generalized inverse (concept with illustrations). Partitioning of matrices and simple properties.

Unit V: Characteristic roots and Characteristic vector, Properties of characteristic roots, Cayley Hamilton theorem, Quadratic forms, Linear orthogonal transformation and their digitalization

Suggested Readings:

1. Lay David C.: Linear Algebra and its Applications, Addison Wesley, 2000.
2. Schaum's Outlines : Linear Algebra, Tata McGraw-Hill Edition, 3rd Edition, 2006.
3. Krishnamurthy V., Mainra V.P. and Arora J.L.: An Introduction to Linear Algebra (II, III, IV, V).
4. Jain P.K. and Khalil Ahmad: Metric Spaces, Narosa Publishing House, New Delhi, 1973
5. Biswas, S. (1997): A Textbook of Matrix Algebra, New Age International, 1997.
6. Gupta S.C.: An Introduction to Matrices (Reprint). Sultan Chand & Sons, 2008.
7. Artin M.: Algebra. Prentice Hall of India, 1994.
8. Datta K.B.: Matrix and Linear Algebra. Prentice Hall of India Pvt. Ltd., 2002.
9. Hadley G.: Linear Algebra. Narosa Publishing House (Reprint), 2002.
10. Searle S.R.: Matrix Algebra Useful for Statistics. John Wiley & Sons., 1982.

Practical

Credits – 2, Full Marks – 25,

1. Linear dependence & independence of vectors.
2. Relation between roots & coefficients
3. Evaluation of roots of cubic and biquadratic equation.
4. Properties and applications of Matrices related problems
5. Applications of Linear equations.
6. Properties of characteristics roots and vectors

SEMESTER-III

English SEC-I – Communicative English & English Writing skill 50 (10+40) marks, 02 credits

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

Statistics GE III: Introduction to Operations Research

(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: Introduction to Operations Research, phases of O.R., model building, various types of O.R. problems. Linear Programming Problem, Mathematical formulation of the L.P.P, graphical solutions of a L.P.P.

Unit II: Optimum solution to a L.P.P: Simplex method, concept of artificial variables and Charne's big M-technique. Graphically identifying special cases of L.P.P. Concept of duality in L.P.P.

Unit III: Transportation Problem: Initial solution by North West corner rule, Least cost method and Vogel's approximation method (VAM), MODI's method to find the optimal solution.

Unit IV: Assignment problem: Hungarian method to find optimal assignment.

Unit V: Game theory: Rectangular game, minimax-maximin principle, solution to rectangular game using graphical method, dominance property to reduce the game matrix and solution to rectangular game with mixed strategy. Networking: Shortest route problem

Suggested Reading:

1. Taha, H. A. (2007): Operations Research: An Introduction, 8th Edition, Prentice Hall of India.
2. SwarupKanti, Gupta, P.K. and Manmohan (2007): Operations Research, 13th Edition, Sultan Chand and Sons.
3. Ravindran, A, Phillips, D.T., Solberg, J.J.(2005): Operations Research- Principles and Practice, John Wiley & Sons.

GE III: LAB WORK: Using TORA/WINQSB/LINGO

Credits – 2, Full Marks – 25,

1. Mathematical formulation of L.P.P and solving the problem using graphical method
2. Simplex technique to solve L.P.P and reading dual solution from the optimal table
3. Charne's Big M method involving artificial variables.
4. Identifying Special cases: Degenerate solution, Unbounded solution, Alternate solution and Infeasible solution by Graphical method and interpretation
5. Allocation problem using Transportation model
6. Allocation problem using Assignment model
7. Networking : Shortest route problem
8. Problems based on game matrix: $m \times n$ / $2 \times n$ rectangular and Mixed strategy

Statistics CC V: Sampling Distributions

(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: Limit laws: convergence in probability, almost sure convergence, convergence in mean square and convergence in distribution and their inter relations, Chebyshev's inequality, W.L.L.N., S.L.L.N. and their applications, De-Moivre Laplace theorem, Central Limit Theorem (C.L.T.) for i.i.d. variates, applications of C.L.T. and Liapunov Theorem (without proof). Order Statistics: Introduction, distribution of the rth order statistic, smallest and largest order statistics. Joint distribution of rth and sth order statistics, distribution of sample median and sample range.

Unit II: Definitions of random sample, parameter and statistic, sampling distribution of a statistic, sampling distribution of sample mean, standard errors of sample mean, sample variance and sample proportion. Null and alternative hypotheses, level of significance, Type I and Type II errors, their probabilities and critical region. Large sample tests, use of CLT for testing single proportion, difference of two proportions, single mean, difference of two means, standard deviation and difference of standard deviations by classical and p-value approaches.

Unit III: Exact sampling distribution: Definition and derivation of p.d.f. of χ^2 with n degrees of freedom (d.f.) using m.g.f., nature of p.d.f. curve for different degrees of freedom, mean, variance, m.g.f., cumulant generating function, mode, additive property and limiting form of χ^2 distribution. Tests of significance and confidence intervals based on χ^2 distribution.

Unit IV: Exact sampling distributions: Student's and Fishers t-distribution, Derivation of its p.d.f., nature of probability curve with different degrees of freedom, mean, variance, moments and limiting form of t distribution. Test of significance based on dist.

Unit V: Snedecore's F-distribution: Derivation of p.d.f., nature of p.d.f. curve with different degrees of freedom, mean, variance and mode. Distribution of $1/F(n_1, n_2)$. Relationship between t, F and χ^2 distributions. Test of significance and confidence Intervals based on t and F distributions.

Suggested Reading:

1. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2003): *An Outline of Statistical Theory*, Vol. I, 4th Edn. World Press, Kolkata.
2. Rohatgi V. K. and Saleh, A.K. Md. E. (2009): *An Introduction to Probability and Statistics*. 2ndEdn. (Reprint) John Wiley and Sons.
3. Hogg, R.V. and Tanis, E.A. (2009): *A Brief Course in Mathematical Statistics*. Pearson Education.
4. Johnson, R.A. and Bhattacharya, G.K. (2001): *Statistics-Principles and Methods*, 4th Edn. John Wiley and Sons.
5. Mood, A.M., Graybill, F.A. and Boes, D.C. (2007): *Introduction to the Theory of Statistics*, 3rd Edn. (Reprint). Tata McGraw-Hill Pub. Co. Ltd.

CC V: PRACTICAL/ LAB. WORK:
Credits -2, Marks - 25
List of Practical

1. Testing of significance and confidence intervals for single proportion and difference of two proportions
2. Testing of significance and confidence intervals for single mean and difference of two means and paired tests.
3. Testing of significance and confidence intervals for difference of two standard deviations.
4. Exact Sample Tests based on Chi-Square Distribution.
5. Testing if the population variance has a specific value and its confidence intervals.
6. Testing of goodness of fit.
7. Testing of independence of attributes.
8. Testing based on 2 X 2 contingency table without and with Yates' corrections.
9. Testing of significance and confidence intervals of an observed sample correlation coefficient.
10. Testing and confidence intervals of equality of two population variances

Statistics CC VI: Survey Sampling and Indian Official Statistics

(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: Concept of population and sample, complete enumeration versus sampling, sampling and non-sampling errors. Types of sampling: non-probability and probability sampling, basic principle of sample survey, simple random sampling with and without replacement, definition and procedure of selecting a sample, estimates of: population mean, total and proportion, variances of these estimates, estimates of their variances and sample size determination

Unit II: Stratified random sampling: Technique, estimates of population mean and total, variances of these estimates, proportional and optimum allocations and their comparison with SRS. Practical difficulties in allocation, estimation of gain in precision, post stratification and its performance. Systematic Sampling: Technique, estimates of population mean and total, variances of these estimates ($N=nk$). Comparison of systematic sampling with SRS and stratified sampling in the presence of linear trend and corrections.

Unit III: Introduction to Ratio method of estimation, first approximation to the population mean and total (for SRS of large size), variances of these estimates and estimates of these variances,

Unit IV: Variances in terms of correlation coefficient for regression method of estimation and their comparison with SRS. Cluster sampling (equal clusters only) estimation of population mean and its variance, comparison (with and without randomly formed clusters). Relative efficiency of cluster sampling with SRS in terms of intra class correlation. Concept of sub sampling. Regression methods of estimation.

Unit V: Present official statistical system in India, Methods of collection of official statistics, their reliability and limitations. Role of Ministry of Statistics & Program Implementation (MoSPI), Central Statistical Office (CSO), National Sample Survey Office (NSSO), and National Statistical Commission. Government of India's Principal publications containing data on the topics such as population, industry and finance.

Suggested reading:

1. Cochran W.G. (1984): Sampling Techniques (3rd Ed.), Wiley Eastern.
2. Sukhatme, P.V., Sukhatme, B.V. Sukhatme, S. Asok, C. (1984). Sampling Theories of Survey With Application, IOWA State University Press and Indian Society of Agricultural Statistics
3. Murthy M.N. (1977): Sampling Theory & Statistical Methods, Statistical Pub. Society, Calcutta.
4. Des Raj and Chandhok P. (1998): Sample Survey Theory, Narosa Publishing House
5. Goon A.M., Gupta M.K. and Dasgupta B. (2001): Fundamentals of Statistics (Vol.2), World Press.
6. Guide to current Indian Official Statistics, Central Statistical Office, GOI, New Delhi.
7. <http://mospi.nic.in/>

CC VI: PRACTICAL/LAB. WORK:
Credits -2, Marks - 25
List of Practical

1. To select a SRS with and without replacement.
2. For a population of size 5, estimate population mean, population mean square and population variance. Enumerate all possible samples of size 2 by WR and WOR and establish all properties relative to SRS.
3. For SRSWOR, estimate mean, standard error, the sample size
4. Stratified Sampling: allocation of sample to strata by proportional and Neyman's methods
Compare the efficiencies of above two methods relative to SRS
5. Estimation of gain in precision in stratified sampling.
6. Comparison of systematic sampling with stratified sampling and SRS in the presence of a linear trend.
7. Ratio and Regression estimation: Calculate the population mean or total of the population. Calculate mean squares. Compare the efficiencies of ratio and regression estimators relative to SRS.
8. Cluster sampling: estimation of mean or total, variance of the estimate, estimate of intra-class correlation coefficient, efficiency as compared to SRS.

Statistics CC VII: Mathematical 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

Real Analysis: Representation of real numbers as points on the line and the set of real numbers as complete ordered field. Bounded and unbounded sets, neighborhoods and limit points, Supremum and infimum, derived sets, open and closed sets, sequences and their convergence, limits of some special sequences such as $r^n, \left(1 + \frac{1}{n}\right)^n$ and $n^{\frac{1}{n}}$ and Cauchy's general principle of convergence, Cauchy's first theorem on limits, monotonic sequences, limit superior and limit inferior of a bounded sequence.

Unit-II: Infinite series, positive term series and their convergence, Comparison test, D'Alembert's ratio test, Cauchy's n^{th} root test, Raabe's test, Gauss test, Cauchy's condensation test and integral test (Statements and Examples only). Absolute convergence of series, Leibnitz's test for the convergence of alternating series, Conditional convergence. Indeterminate form, L' Hospital's rule.

Unit-III: Review of limit, continuity and differentiability, uniform Continuity and boundedness of a function. Rolle's and Lagrange's Mean Value theorems. Taylor's theorem with Lagrange's and Cauchy's form of remainder (without proof). Taylor's and Maclaurin's series expansions of $\sin x, \cos x, e^x, (1+x)^n, \log(1+x)$.

Unit-IV: Numerical Analysis: Factorial, finite differences and interpolation. Operators, E and divided difference. Newton's forward, backward and divided differences interpolation formulae. Lagrange's interpolation formulae. Central differences, Gauss and Stirling interpolation formulae.

Unit- V: Numerical integration. Trapezoidal rule, Simpson's one-third rule, three-eighths rule, Weddle's rule with error terms. Stirling's approximation to factorial n. Solution of difference equations of first order.

Suggested Readings

1. Malik S.C. and Savita Arora: Mathematical Analysis, Second Edition, Wiley Eastern Limited, New Age International Limited, New Delhi, 1994.
2. Somasundram D. and Chaudhary B.: A First Course in Mathematical Analysis, Narosa Publishing House, New Delhi, 1987.
3. Gupta S.L. and Nisha Rani: Principles of Real Analysis, Vikas Publ. House Pvt. Ltd., New Delhi, 1999
4. Appostol T.M.: Mathematical Analysis, Second Edition, Narosa Publishing House, New Delhi, 1987.
5. Shanti Narayan: A course of Mathematical Analysis, 12th revised Edition, S. Chand & Co. (Pvt.) Ltd., New Delhi, 1987.
6. Singal M.K. and Singal A.R.: A First Course in Real Analysis, 24th Edition, R. Chand & Co., New Delhi, 2003.
7. Bartle, R. G. and Sherbert, D. R. (2002): Introduction to Real Analysis(3rd Edition), John Wiley and Sons (Asia) Pte. Ltd., Singapore.
8. Ghorpade, Sudhir R. and Limaye, Balmohan V. (2006): A Course in Calculus and Real Analysis, Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint.

CC VII: PRACTICAL/LAB. WORK:
Credits – 2, Full Marks – 25,

1. Finite difference and operators
2. Newton's forward and backward & divided difference interpolation formula
3. Lorange's Interpolation formula
4. Gauss & Stirling central difference interpolation formula
5. Trapezoidal Rule
6. Simpson's 1/3rd & 3/8 rule
7. Weddle's Rule.
8. Solution of difference equation of 1st order

SEMESTER IV
Statistics SEC II: Statistical Techniques for Research Methods
(Credits: 02), marks – 50 (10+40),

Statistical Techniques provide scientific approaches to develop the domain of human knowledge largely through empirical studies. The course aims at enabling students understand basic concepts and aspects related to research, data collection, analyses and interpretation.

Unit I: Introduction: Meaning, objection and motivation in research, types of research, research approach, significance of research. Research problems: definition, selection and necessity of research problems.

Unit II: Survey Methodology and Data Collection, inference and error in surveys, the target populations, sampling frames and coverage error, methods of data collection, non-response, questions and answers in surveys.

Unit III: Processing, Data Analysis and Interpretation: Review of various techniques for data analysis covered in core statistics papers, techniques of interpretation, precaution in interpretation.

Unit IV: Develop a questionnaire, collect survey data pertaining to a research problem (such as gender discriminations in private v/s government sector,

Unit V : Unemployment rates, removal of subsidy, impact on service class v/s unorganized sectors), interpret the results and draw inferences.

SUGGESTED READING:

1. Kothari, C.R. (2009): Research Methodology: Methods and Techniques, 2nd Revised Edition reprint, New Age International Publishers.
2. Kumar, R (2011): Research Methodology: A Step - by - Step Guide for Beginners, SAGE publications.

Statistics GE IV: Applied Statistics
(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: Economic Time Series: Components of time series, Decomposition of time series- Additive and multiplicative model with their merits and demerits, Illustrations of time series. Measurement of trend by method of free-hand curve, method of semi-averages and method of least squares (linear, quadratic and modified exponential). Measurement of seasonal variations by method of ratio to trend.

Unit II: Index numbers: Definition, Criteria for a good index number, different types of index numbers. Construction of index numbers of prices and quantities, consumer price index number. Uses and limitations of index numbers.

Unit III: Statistical Quality Control: Importance of statistical methods in industrial research and practice. Determination of tolerance limits. Causes of variations in quality: chance and assignable. General theory of control charts, process & product control, Control charts for variables: X- bar and R-charts. Control charts for attributes: p and c-charts

Unit IV: Demographic Methods: Introduction, measurement of population, rates and ratios of vital events. Measurement of mortality: CDR, SDR (w.r.t. Age and sex), IMR, Standardized death rates.

Unit V: Life (mortality) tables: definition of its main functions and uses. Measurement of fertility and reproduction: CBR, GFR, and TFR. Measurement of population growth: GRR, NRR.

Suggested Reading:

1. Mukhopadhyay, P. (1999): Applied Statistics, New Central Book Agency, Calcutta.
2. Gun, A.M., Gupta, M.K. and Dasgupta, B. (2008): Fundamentals of Statistics, Vol. II, 9th Edition World Press, Kolkata.
3. Gupta, S. C. and Kapoor, V.K. (2008): Fundamentals Of Applied Statistics, 4th Edition(Reprint), Sultan Chand & Sons
4. Montogomery, D. C. (2009): Introduction to Statistical Quality Control, 6th Edition, Wiley India Pvt. Ltd.

PRACTICAL/LAB WORK

Credits -2, Marks - 25

List of Practical

1. Measurement of trend: Fitting of linear, quadratic trend, exponential curve and plotting of trend values and comparing with given data graphically.
2. Measurement of seasonal indices by Ratio-to-trend method and plotting of trend values and comparing with given data graphically.
3. Construction of price and quantity index numbers by Laspeyre's formula, Paasche's formula, Marshall-Edgeworth's formula, Fisher's Formula. Comparison and interpretation.
4. Construction of wholesale price index number, fixed base index number and consumer price index number with interpretation
5. Construction and interpretation of X bar & R-chart
6. Construction and interpretation p-chart (fixed sample size) and c-chart
7. Computation of measures of mortality
8. Completion of life table
9. Computation of measures of fertility and population growth

Statistics CC VIII: Statistical Inference
(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:

Estimation: Concepts of estimation, unbiasedness, sufficiency, consistency and efficiency. Factorization theorem. Complete statistic, Minimum variance unbiased estimator (MVUE), Rao-Blackwell and Lehmann-Scheffe theorems and their applications. Cramer-Rao inequality and MVB estimators(statement and applications).

Unit II

Methods of Estimation: Method of moments, method of maximum likelihood estimation, method of minimum Chi-square, basic idea of Bayes estimators.

Unit III

Principles of test of significance: Null and alternative hypotheses (simple and composite), Type-I and Type-II errors, critical region, level of significance, size and power, best critical region, most powerful test, uniformly most powerful test, Neyman Pearson Lemma (statement and applications to construct most powerful test). Likelihood ratio test, properties of likelihood ratio tests (without proof).

Unit IV

Sequential Analysis: Sequential probability ratio test (SPRT) for simple vs simple hypotheses. Fundamental relations among α , β , A and B, determination of A and B in practice.

Unit V

Wald's fundamental identity and the derivation of operating characteristics (OC) and average sample number (ASN) functions, examples based on normal, Poisson, binomial and exponential distributions.

SUGGESTED READINGS:

1. Goon A.M., Gupta M.K.: Das Gupta.B. (2005), Fundamentals of Statistics, Vol. I, World Press, Calcutta.
2. Rohatgi V. K. and Saleh, A.K. Md. E. (2009): An Introduction to Probability and Statistics. 2ndEdn. (Reprint) John Wiley and Sons.
3. Miller, I. and Miller, M. (2002) : John E. Freund's Mathematical Statistics (6th addition, low price edition), Prentice Hall of India.
4. Dudewicz, E. J., and Mishra, S. N. (1988): Modern Mathematical Statistics. John Wiley & Sons.
5. Mood A.M, Graybill F.A. and Boes D.C.: Introduction to the Theory of Statistics, McGraw Hill.
6. Bhat B.R, Srivenkatramana T and Rao Madhava K.S. (1997) Statistics: A Beginner's Text, Vol. I, New Age International (P) Ltd.
7. Snedecor G.W and Cochran W.G.(1967) Statistical Methods. Iowa State University Press.

CC VIII LAB: PRACTICAL WORK:

Credits – 02, Marks-25,

List of Practical

1. Unbiased estimators (including unbiased but absurd estimators)
2. Consistent estimators, efficient estimators and relative efficiency of estimators.
3. Cramer-Rao inequality and MVB estimators
4. Sufficient Estimators – Factorization Theorem, Rao-Blackwell theorem, Complete Sufficient estimators
5. Lehman-Scheffe theorem and UMVUE
6. Maximum Likelihood Estimation
7. Asymptotic distribution of maximum likelihood estimators
8. Estimation by the method of moments, minimum Chi-square
9. Type I and Type II errors
10. Most powerful critical region (NP Lemma)
11. Uniformly most powerful critical region
12. Unbiased critical region
13. Power curves
14. Likelihood ratio tests for simple null hypothesis against simple alternative hypothesis
15. Likelihood ratio tests for simple null hypothesis against composite alternative hypothesis
16. Asymptotic properties of LR tests
17. SPRT procedure
18. OC function and OC curve
19. ASN function and ASN curve

Statistics CC IX: Linear Models

(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

Gauss-Markov set-up: Theory of linear estimation, Estimability of linear parametric functions, Method of least squares, Gauss-Markov theorem, Estimation of error variance.

Unit II

Regression analysis: Simple regression analysis, Estimation and hypothesis testing in case of simple and multiple regression models, Concept of model matrix and its use in estimation.

Unit III

Analysis of variance: Definitions of fixed, random and mixed effect models, analysis of variance and covariance in one-way classified data for fixed effect models,

Unit IV

Analysis of variance and covariance in two-way classified data with one observation per cell for fixed effect models

Unit V

Model checking: Prediction from a fitted model, Violation of usual assumptions concerning normality, Homoscedasticity and collinearity, Diagnostics using quantile-quantile plots

SUGGESTED READINGS:

1. Weisberg, S. (2005). Applied Linear Regression (Third edition). Wiley.
2. Wu, C. F. J. And Hamada, M. (2009). Experiments, Analysis, and Parameter Design Optimization (Second edition), John Wiley.
3. Renchner, A. C. And Schaalje, G. B. (2008). Linear Models in Statistics (Second edition), John Wiley and Sons.

CC IX: PRACTICAL / LAB. WORK:

Credits – 02, Marks-25,

List of Practical

1. Estimability when X is a full rank matrix and not a full rank matrix
2. Distribution of Quadratic forms
3. Simple Linear Regression
4. Multiple Regression
5. Tests for Linear Hypothesis
6. Bias in regression estimates
7. Lack of fit
8. Orthogonal Polynomials
9. Analysis of Variance of a one way classified data
10. Analysis of Variance of a two way classified data with one observation per cell
11. Analysis of Covariance of a one way classified data
12. Analysis of Covariance of a two way classified data

Statistics CC X: Statistical Quality Control

(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: Quality: Definition, dimensions of quality, historical perspective of quality control and improvements starting from World War II, historical perspective of Quality Gurus and Quality Hall of Fame. Quality system and standards: Introduction to ISO quality standards, Quality registration. Statistical Process Control - Seven tools of SPC, chance and assignable Causes of quality variation. Statistical Control Charts- Construction and Statistical basis of 3- σ Control charts, Rational Sub-grouping.

Unit II: Control charts for variables: X-bar & R-chart, X-bar & s-chart. Control charts for attributes: np-chart, p-chart, c-chart and u-chart. Comparison between control charts for variables and control charts for attributes. Analysis of patterns on control chart, estimation of process capability.

Unit III: Acceptance sampling plan: Principle of acceptance sampling plans. Single and Double sampling plan their OC, AQL, LTPD, AOQ, AOQL, ASN, ATI functions with graphical interpretation, use and interpretation of Dodge and Romig's sampling inspection plan tables.

Unit IV: Introduction to Six-Sigma: Overview of Six Sigma, Lean Manufacturing and Total Quality Management (TQM). Organizational Structure and Six Sigma training plans- Selection Criteria for Six-Sigma roles and training plans.

Unit V: Voice of customers (VOC): Importance and VOC data collection. Critical to Quality (CTQ). Introduction to DMAIC using one case study: Define Phase, Measure Phase, Analyse Phase, Improve Phase and Control Phase.

SUGGESTED READING:

1. Montgomery, D. C. (2009): Introduction to Statistical Quality Control, 6th Edition, Wiley India Pvt. Ltd.
2. Goon A.M., Gupta M.K. and Dasgupta B. (2002): Fundamentals of Statistics, Vol. I & II, 8th Edn. The World Press, Kolkata.
3. Mukhopadhyay, P (2011): Applied Statistics, 2nd edition revised reprint, Books and Allied(P) Ltd.
4. Montgomery, D. C. and Runger, G.C. (2008): Applied Statistics and Probability for Engineers, 3rd Edition reprint, Wiley India Pvt. Ltd.
5. Ehrlich, B. Harris (2002): Transactional Six Sigma and Lean Servicing, 2nd Edition, St. Lucie Press.
6. Hoyle, David (1995): ISO Quality Systems Handbook, 2nd Edition, Butterworth Heinemann Publication.

CC X: PRACTICAL/LAB. WORK:
Credits – 02, Marks-25,
List of Practical

1. Construction and interpretation of statistical control charts
 - X-bar &R-chart
 - X-bar &s-chart
 - np-chart
 - p-chart
 - c-chart
 - u-chart
2. Single sample inspection plan: Construction and interpretation of OC, AQL, LTPD, ASN, ATI, AOQ, AOQL curves
3. Calculation of process capability and comparison of 3-sigma control limits with specification limits.
4. Use a case study to apply the concept of six sigma application in DMAIC: practical application.

SEMESTER-V
Statistics DSE I: Operations Research
(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: Introduction to Operations Research, phases of O.R., model building, various types of O.R. problems. Linear Programming Problem, Mathematical formulation of the L.P.P, graphical solutions of a L.P.P.

Unit II: Simplex method for solving L.P.P Charne's M-technique for solving involving artificial variables. Special cases of L.P.P.

Unit III: Concept of Duality in L.P.P: Dual simplex method. Post-optimality analysis

Unit IV: Transportation Problem: Initial solution by North West corner rule, Least cost method and Vogel's approximation method (VAM), MODI's method to find the optimal solution, special cases of transportation problem. Assignment problem: Hungarian method to find optimal assignment, special cases of assignment problem.

Unit V: Game theory: Rectangular game, minimax-maximin principle, solution to rectangular game using graphical method, dominance and modified dominance property to reduce the game matrix and solution to rectangular game with mixed strategy.

Suggested reading:

1. Taha, H. A. (2007): Operations Research: An Introduction, 8th Edition, Prentice Hall of India.
2. KantiSwarup, Gupta, P.K. and Manmohan (2007): Operations Research, 13th Edition, Sultan Chand and Sons.
3. Hadley, G: (2002) : Linear Programming, Narosa Publications
4. Hillier, F.A and Lieberman, G.J. (2010): Introduction to Operations Research- Concepts and cases, 9th Edition, Tata McGraw Hill

DSE -I: PRACTICAL/LAB WORK (Using TORA/WINQSB/LINGO)
Credits – 02, Marks-25,
List of Practical

1. Mathematical formulation of L.P.P and solving the problem using graphical method, Simplex technique and Charne's Big M method involving artificial variables.
2. Identifying Special cases by Graphical and Simplex method and interpretation
 - a. Degenerate solution
 - b. Unbounded solution
 - c. Alternate solution
 - d. Infeasible solution
3. Post-optimality
 - a. Addition of constraint
 - b. Change in requirement vector
 - c. Addition of new activity
 - d. Change in cost vector
4. Allocation problem using Transportation model
5. Allocation problem using Assignment model
6. Networking problem
 - a. Minimal spanning tree problem
 - b. Shortest route problem
7. Problems based on game matrix
 - a. Graphical solution to $m \times 2 / 2 \times n$ rectangular game
 - b. Mixed strategy
8. To find optimal inventory policy for EOQ models and its variations
9. To solve all-Units quantity discounts model

Statistics DSE II: Time Series 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:

Introduction to times series data, application of time series from various fields, Components of a times series, Decomposition of time series. Trend: Estimation of trend by free hand curve method, method of semi averages.

Unit II:

Fitting various mathematical curves Trend Cont.: Method of moving averages. Detrending. Effect of elimination of trend on other components of the time series.

Unit III:

Seasonal Component: Estimation of seasonal component by Method of simple averages, Ratio to Trend, Seasonal Component cont: Ratio to Moving Averages and Link Relative method, Deseasonalization. Cyclic Component: Harmonic Analysis.

Unit IV:

Some Special Processes: Moving-average (MA) process and Autoregressive (AR) process of orders one and two. Random Component: Variate component method. Forecasting: Exponential smoothing methods.

Unit V:

Stationary Time series: Weak stationarity, autocorrelation function and correlogram of moving average.

SUGGESTED READING:

1. Kendall M.G. (1976): Time Series, Charles Griffin.
2. Chatfield C. (1980): The Analysis of Time Series –An Introduction, Chapman & Hall.
3. Mukhopadhyay P. (2011): Applied Statistics, 2nd ed. Revised reprint, Books and Allied

PRACTICAL / LAB WORK

Credits – 02, Marks-25,

List of Practical

1. Fitting and plotting of modified xponential curve
2. Fitting and plotting of Gompertz curve
3. Fitting and plotting of logistic curve
4. Fitting of trend by Moving Average Method
5. Measurement of Seasonal indices Ratio-to-Trend method
6. Measurement of Seasonal indices Ratio-to-Moving Average method
7. Measurement of seasonal indices Link Relative method
8. Calculation of variance of random component by variate difference method
9. Forecasting by exponential smoothing
10. Forecasting by short term forecasting methods.

Statistics CC XI: Stochastic Processes and Queuing Theory

(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: Probability Distributions: Generating functions, Bivariate probability generating function. Stochastic Process: Introduction, Stationary Process.

Unit II: Markov Chains: Definition of Markov Chain, transition probability matrix, order of Markov chain, Markov chain as graphs, higher transition probabilities. Classification of states and chains, stability of Markov system.

Unit III: Poisson Process: postulates of Poisson process, properties of Poisson process, inter-arrival time, pure birth process, Birth and death process, pure death process.

Unit IV: Queuing System: General concept, steady state distribution, queuing model, M/M/1 with finite and infinite system capacity.

Unit V: Waiting time distribution (without proof). Gambler's Ruin Problem: Classical ruin problem, expected duration of the game.

SUGGESTED READING:

1. Medhi, J. (2009): Stochastic Processes, New Age International Publishers.
2. Basu, A.K. (2005): Introduction to Stochastic Processes, Narosa Publishing.
3. Bhat, B.R. (2000): Stochastic Models: Analysis and Applications, New Age International Publishers.
4. Taha, H. (1995): Operations Research: An Introduction, Prentice- Hall India.
5. Feller, William (1968): Introduction to probability Theory and Its Applications, Vol I, 3rd Edition, Wiley International.

CC XI: PRACTICAL/LAB. WORK

Credits – 02, Marks-25,

List of Practical

1. Calculation of transition probability matrix
2. Identification of characteristics of reducible and irreducible chains.
3. Identification of types of classes
4. Identification of ergodic transition probability matrix
5. Stationarity of Markov chain and graphical representation of Markov chain
6. Computation of probabilities in case of generalizations of independent Bernoulli trials
7. Calculation of probabilities for given birth and death rates and vice versa
8. Calculation of probabilities for Birth and Death Process
9. Computation of inter-arrival time for a Poisson process.
10. Calculation of Probability and parameters for (M/M/1) model and change in behaviour of queue as N tends to infinity.
11. Calculation of generating function and expected duration for different amounts of stake.
12. Computation of probabilities and expected duration between players.

Statistics CC XII: Statistical Computing Using C/C++ Programming

(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: History and importance of C/C++. Components, basic structure programming, character set, C/C++ tokens, Keywords and Identifiers and execution of a C/C++ program. Data types: Basic data types, Enumerated data types, derived data types. Constants and variables: declaration and assignment of variables, Symbolic Constants, overflow and underflow of data.

Operators and Expressions: Arithmetic, relational, logical, assignment, increment/decrement, operators, precedence of operators in arithmetic, relational and logical expression. Implicit and explicit type conversions in expressions, library functions. Managing input and output operations: reading and printing formatted and unformatted data

Unit II

Decision making and branching - if...else, nesting of if...else, else if ladder, switch, conditional (?) operator. Looping in C/C++: for, nested for, while, do...while, jumps in and out of loops.

Arrays: Declaration and initialization of one-dim and two-dim arrays. Character arrays and strings: Declaring and initializing string variables, reading and writing strings from Terminal (using scanf and printf only).

Unit III:

User- defined functions: A multi-function program using user-defined functions, definition of functions, return values and their types, function prototypes and calls. 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.

Unit IV:

Recursion function. Passing arrays to functions, Storage class of Variables.

Pointers: Declaration and initialization of pointer variables, accessing the address of a variable, accessing a variable through its pointer, pointer expressions, pointer increments/decrement and scale factor. Pointers and arrays, arrays of pointers, pointers as function arguments, functions returning pointers

Unit V:

Structure: Definition and declaring, initialization, accessing structure members, copying and comparison of structure variables, array of structures, structure pointers. Dynamic memory allocation functions :malloc, calloc and free. Pre processors: Macro substitution, macro with argument File inclusion in C/C++: Defining and opening a file (only r, w and a modes), closing a file, I/O operations on files-fscanf and fprintf functions.

Suggested reading:

1. Kernighan, B.W. and Ritchie, D. (1988): C Programming Language, 2nd Edition, Prentice Hall.
2. Balagurusamy, E. (2011): Programming in ANSI C, 6th Edition, Tata McGraw Hill.
3. Gottfried, B.S. (1998): Schaum's Outlines: Programming with C, 2nd Edition, Tata McGraw Hill

CC XII: PRACTICAL/LAB WORK (Using C/C++ Programming Language)
Credits – 02, Marks-25,
List of Practical

1. Computation of Simple and compound interest
2. Roots of a quadratic equation (with imaginary roots also)
3. Sum of natural numbers using recursion
4. Sum of series
5. Variance and coefficient of variation of a Grouped Frequency Data
6. Preparing a frequency table
7. Value of n! using recursion
8. Random number generation from uniform, exponential, normal(using CLT) and gamma distribution, calculate sample mean and variance and compare with population parameters.
9. Matrix addition, subtraction, multiplication Transpose and Trace
10. Calculation of the value of $\sin x = x - \frac{x^3}{3!} + \dots$
11. Sum of a divergent series
12. Finding value of e^x and e^{-x}
13. Lagrange's Interpolation
14. Trapezoidal Rule
15. Aggregate and Percentage of marks
16. Area of a triangle and a right angled triangle
17. Fitting of lines of regression

SEMESTER VI

Statistics DSE III: Demography and Vital Statistics

(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

Population Theories: Coverage and content errors in demographic data, use of balancing equations and Chandrasekharan-Deming formula to check completeness of registration data. Adjustment of age data, use of Myer and UN indices, Population composition, dependency ratio.

Unit II: Introduction and sources of collecting data on vital statistics, errors in census and registration data. Measurement of population, rate and ratio of vital events. Measurements of Mortality: Crude Death Rate (CDR), Specific Death Rate (SDR), Infant Mortality, Rate (IMR) and Standardized Death Rates.

Unit III: Stationary and Stable population, Central Mortality Rates and Force of Mortality. Life(Mortality) Tables: Assumption, description, construction of Life Tables and Uses of Life Tables.

Unit IV: Abridged Life Tables; Concept and construction of abridged life tables by Reed-Merrell method. Measurements of Fertility: Crude Birth Rate (CBR), General Fertility Rate (GFR), Specific Fertility Rate (SFR) and Total Fertility Rate (TFR).

Unit V: Measurement of Population Growth: Crude rates of natural increase, Pearl's Vital Index, Gross Reproduction Rate (GRR) and Net Reproduction Rate (NRR).

SUGGESTED READING:

1. Mukhopadhyay P. (1999): Applied Statistics, Books and Allied (P) Ltd.
2. Gun, A.M., Gupta, M.K. and Dasgupta, B. (2008): Fundamentals of Statistics, Vol. II, 9th Edition, WorldPress.
3. Biswas, S. (1988): Stochastic Processes in Demography & Application, Wiley Eastern Ltd.
4. Croxton, Fredrick E., Cowden, Dudley J. and Klein, S. (1973): Applied General Statistics, 3rd Edition. Prentice Hall of India Pvt. Ltd.
5. Keyfitz N., Beckman John A.: Demography through Problems S-Verlag New york.

DSE-III: PRACTICAL/LAB. WORK:

Credits – 02, Marks-25,

List of Practical

1. To calculate CDR and Age Specific death rate for a given set of data
2. To find Standardized death rate by:- (i) Direct method (ii) Indirect method
3. To construct a complete life table
4. To fill in the missing entries in a life table
5. To calculate probabilities of death at pivotal ages and use it construct abridged life table using (i) Reed-Merrell Method, (ii) Greville's Method and (iii) King's Method
6. To calculate CBR, GFR, SFR, TFR for a given set of data
7. To calculate Crude rate of Natural Increase and Pearle's Vital Index for a given set of data
8. Calculate GRR and NRR for a given set of data and compare them.

**Statistics DSE IV:
Dissertation / Project Work
Full Marks - 100**

Objective: The aim of the course is to initiate students to write and present a statistical report, under the supervision of a faculty, on some area of human interest. The project work will provide hands on training to the students to deal with data emanating from some real life situation and propel them to dwell on some theory or relate it to some theoretical concepts.

**STATISTICS CC XIII: Design of Experiments
(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: Experimental designs: Role, historical perspective, terminology, experimental error, basic principles, uniformity trials, fertility contour maps, choice of size and shape of plots and blocks. Basic designs: Completely Randomized Design (CRD), Randomized Block Design (RBD),

Unit II: Latin Square Design (LSD) – layout, model and statistical analysis, relative efficiency, analysis with missing observations.

Unit III: Incomplete Block Designs: Balanced Incomplete Block Design (BIBD) – parameters, relationships among its parameters, incidence matrix and its properties, Symmetric BIBD,

Unit IV: Factorial experiments: advantages, notations and concepts, 2^2 , 2^3 2^n factorial experiments

Unit V: 3^2 factorial experiments, design and analysis, Total and Partial confounding for 2^n ($n \leq 5$), 3^2 and 3^3 experiments

Suggested readings:

1. Cochran, W.G. and Cox, G.M. (1959): Experimental Design. Asia Publishing House.
2. Das, M.N. and Giri, N.C. (1986): Design and Analysis of Experiments. Wiley Eastern Ltd.
3. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2005): Fundamentals of Statistics. Vol. II, 8thEdn. World Press, Kolkata.
4. Kempthorne, O. (1965): The Design and Analysis of Experiments. John Wiley.
5. Montgomery, D. C. (2008): Design and Analysis of Experiments, John Wiley.

**CC XIII: PRACTICAL / LAB. WORK:
Credits – 02, Marks-25,
List of Practical**

1. Analysis of a CRD
2. Analysis of an RBD
3. Analysis of an LSD
1. Analysis of an RBD with one missing observation
2. Analysis of an LSD with one missing observation
3. Intra Block analysis of a BIBD
4. Analysis of 2^2 and 2^3 factorial in CRD and RBD
5. Analysis of 2^2 and 2^3 factorial in LSD
6. Analysis of a completely confounded two level factorial design in 2 blocks
7. Analysis of a completely confounded two level factorial design in 4 blocks

8. Analysis of a partially confounded two level factorial design
9. Analysis of a single replicate of a 2^n design
10. Analysis of a fraction of 2^n factorial design

Statistics CC XIV: Multivariate Analysis and Nonparametric Methods

(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: Bivariate Normal Distribution (BVN): p.d.f. of BVN, properties of BVN, marginal and conditional p.d.f. of BVN. Multivariate Data: Random Vector: Probability mass/density functions, Distribution function, Mean vector & Dispersion matrix, Marginal & Conditional distributions.

Unit II: Multivariate Normal distribution and its properties. Sampling distribution for mean vector and variance- covariance matrix. Multiple and partial correlation coefficient and their properties.

Unit III: Applications of Multivariate Analysis: Discriminant Analysis, Principal Components Analysis.

Unit IV: Factor Analysis Nonparametric Tests: Introduction and Concept, Test for randomness based on total number of runs, Empirical distribution function,

Unit V: Kolmogrov Smirnov test for one sample, Sign tests- one sample and two samples, Wilcoxon-Mann-Whitney test, Kruskal-Wallis test.

Suggested Reading:

1. Anderson, T.W. (2003): An Introduction to Multivariate Statistical Analysis, 3rdEdn., John Wiley
2. Muirhead, R.J. (1982): Aspects of Multivariate Statistical Theory, John Wiley.
3. Kshirsagar, A.M. (1972): Multivariate Analysis, 1stEdn. Marcel Dekker.
4. Johnson, R.A. and Wichern, D.W. (2007): Applied Multivariate Analysis, 6thEdn., Pearson & Prentice Hall
5. Mukhopadhyay, P. :Mathematical Statistics.
6. Gibbons, J. D. and Chakraborty, S (2003): Nonparametric Statistical Inference. 4th Edition. Marcel Dekker, CRC.

CC XIV: PRACTICALS/LAB WORK:

Credits – 02, Marks-25,

List of Practical

1. Multiple Correlation
2. Partial Correlation
3. Bivariate Normal Distribution,
4. Multivariate Normal Distribution
5. Discriminant Analysis
7. Principal Components Analysis
8. Factor Analysis
9. Test for randomness based on total number of runs,
10. Kolmogrov Smirnov test for one sample.
11. Sign test: one sample, two samples, large samples.
12. Wilcoxon-Mann-Whitney U-test
13. Kruskal-Wallis test