



**Curriculum and Syllabus of
B.Sc. (Hons.) in Statistics and Data Science**

Department of Statistics

Faculty of Science

St. Xavier's University, Kolkata

(July 2025 onwards)

**Credit Framework for the Four-Year Undergraduate Programme
B.Sc. (Hons.) in Statistics and Data Science**

Department of Statistics, Faculty of Science, St. Xavier's University, Kolkata

SEM	Major (Discipline specific core courses)	Minor/Elective	Multi- Disciplinary / Inter- Disciplinary Courses	Ability Enhancement Courses	Skill Enhancement Courses	Common Value- Added Courses	Internship / Research Project or Dissertation	Total Credits
I	Descriptive Statistics and Probability- I (4 Credits)	Programming in C/C++ (4 Credits)	Introduction to Economic Theory (3 Credits) Or Cyber Law and IPR (3 Credits)	Communicative English- I (2 Credits)	Personality Development (3 Credits)	Interreligious Studies for global citizenship (2 Credits) and Environmental Education (2 Credits)		20 Credits
II	Descriptive Statistics and Probability-II (4 Credits)	Data Structure and Algorithms using C/C++ (4 Credits)	Development Studies (3 Credits) Or Principles of Management (3 Credits)	Communicative English- II (2 Credits)	Spreadsheet and SPSS in Practice (3 Credits)	Service Learning (2 Credits) and Understanding the Indian Constitution (2 Credits)		20 Credits
III	Mathematical Analysis-I (4 Credits) and Sampling Distribution and Statistical Inference-I (4 Credits)	Database Management System (4 Credits)	Financial Technology (3 Credits) Or Basics of Accounting (3 Credits)	Modern Indian Language I (Bengali/Hindi) (2 Credits) Or Business Communication I (2 Credits)	Python (3 Credits)			20 Credits
IV	Statistical Inference-II (4 Credits) and Linear Algebra and Linear Statistical Models (4 Credits) and Multivariate Analysis (4 Credits)	Data Analysis with R (4 Credits)		Modern Indian Language II (Bengali/Hindi) (2 Credits) Or Business Communication II (2 Credits)			Internship (2 Credits)	20 Credits
V	Numerical Methods and Optimization Techniques (4 Credits) and	Artificial Intelligence (4 Credits)						20 Credits

	Large Sample Theory and Nonparametric Inference (4 Credits) and Regression Analysis (4 Credits) and Statistical Quality Control and Vital Statistics (4 Credits)							
VI	Statistical Inference-III (4 Credits) and Statistical Decision Theory and Bayesian Inference (4 Credits) and Sample Survey-I and Design of experiments-I (4 Credits) and Time Series Analysis-I and Econometrics-I (4 Credits)	Machine Learning with R/Python [4 Credits]						20 Credits
Students who want to undertake 3-year UG programme will be awarded UG Degree in the relevant Discipline /Subject upon securing 120 credits								
VII	Stochastic Process (4 Credit) and <i>Elective-I</i> (4 Credit) Mathematical Analysis-II Or Causal Inference Or Actuarial Statistics and <i>Elective-II</i> (4 Credit) Demography and Official Statistics Or Measure Theoretic Probability Or	Deep Learning with R/ Python (4 Credits)						20 Credits

	Statistical Signal and Image Processing <i>Elective-III</i> (4 Credit) Operations Research Or Bayesian Methods Or Statistical Genetics							
VIII	Discrete Data Analysis [Compulsory] (4 Credits) <i>(Anyone from Special Module-I to Special Module-V in lieu of Dissertation)</i> SM-I: Statistical Inference Parametric Inference (4 Credits) and Nonparametric and Semiparametric Inference (4 Credits) and Technical Project (4 Credits) SM-II: Biostatistics Survival Analysis (4 Credits) and Clinical Trials (4 Credits) and Technical Project (4 Credits) SM-III: Time Series and Econometrics Time Series Analysis-II (4 Credits) and Econometrics-II (4 Credits) and Technical Project (4 Credits) SM-IV: Industrial Statistics	Big Data Analytics [4 Credits]					Dissertation (12 Credits)	20 Credits

	Statistical Quality Management (4 Credits) and Reliability Analysis (4 Credits) and Technical Project (4 Credits) SM-V: Sampling and Experimental Design Sample Survey-II (4 Credits) and Design of Experiments- II (4 Credits) and Technical Project (4 Credits)							
Students will be awarded UG Degree (Honours) with Research in the relevant Curriculum and Credit Framework for Undergraduate Programmes Discipline /Subject provided they secure 160 credits								

MAJOR: Discipline Specific Core Course

MINOR: General Electives

AEC: Ability Enhancement Course

SEC: Skill Enhancement Course

VAC: Value Addition Course

Elective courses and special modules shall be offered as per the university norms and regulations.

B.Sc. (Hons.) in Statistics and Data Science**[Updated up to Semester I and Semester VI]****Total Credit: 160****Semester wise details**

Semester-I							
Number of Papers: 6							
Course Code	Course Title	Course Type	Credits in each course				
			Theory	Practical	Tutorial	Credits	Total Marks
BSDCCR111C	Descriptive Statistics and Probability- I	Major	3	1	0	4	30(CIA) + 45(T) + 25(P)
BSDMER121C	Programming in C/C++	Minor	2	2	0	4	30(CIA) + 20(T) + 50(P)
Any one of the following two multidisciplinary courses							
BECMIR131T	Introduction to Economic Theory	Multi-Disciplin ary	3	0	0	3	30(CIA) +70(T)
	Cyber Law and IPR	Multi-Disciplin ary	3	0	0	3	30(CIA) +70(T)
BENAER141T	Communicative English-I	Ability Enhance ment	2	0	0	2	15(CIA) + 35(T)
BGCSER151T	Personality Development	Skill Enhance ment	3	0	0	3	30(CIA) + 70(T)
Following two common value-added courses are compulsory							
BGCVAR161T	Interreligious Studies for global citizenship	Common Value-Added	2	0	0	2	15(CIA) + 35(T)
BGCVAR171T	Environmental Education	Common Value-Added	2	0	0	2	25(CIA) + 25(T)
Total						20	

Semester-II							
Number of Papers : 5							
Course Code	Course Title	Course Type	Credits in each course				
			Theory	Practical	Tutorial	Credits	
BSDCCR2 11C	Descriptive Statistics and Probability-II	Major	3	1	0	4	30(CIA) + 45(T) + 25(P)
BSDMER2 21C	Data Structure and Algorithms using C/C++	Minor	2	2	0	4	30(CIA) + 20(T) + 50(P)
Any one of the following two multidisciplinary courses							
	Development Studies	Multi-Disciplin ary	3	0	0	3	30(CIA)+ 70(T)
BCMMIR2 31T	Principles of Management	Multi-Disciplin ary	3	0	0	3	30(CIA)+ 70(T)
BENAER2 41T	Communicative English-II	Ability Enhance ment	2	0	0	2	15(CIA) + 35(T)
BSDSER2 51P	Spreadsheet and SPSS in Practice	Skill Enhance ment	0	0	3	3	30(CIA)+ 70(P)
Following two common value-added courses are compulsory							
BGCVAR2 72T	Service Learning	Common Value- Added	1	1	0	2	25(T) +25(P)
	Understanding the Indian Constitution	Common Value- Added	2	0	0	2	15(CIA) + 35(T)
Total						20	

Semester- III							
Number of Papers: 6							
Course Code	Course Title	Course Type	Credits in each course				
			Th eor y	Practical	Tutorial	Credits	
BSDCCR3 11T	Mathematical Analysis-I	Major	4	0	0	4	30(CIA) + 70(T)
BSDCCR3 21C	Sampling Distribution and Statistical Inference-I	Major	3	1	0	4	30(CIA) + 45(T) + 25(P)
BSDME R331C	Database Management System	Minor				4	
Any one of the following two multidisciplinary courses							
BCMMIR 341T	Financial Technology	Multi- Disciplinary	3	0	0	3	30(CIA) +70(T)
	Basics of Accounting	Multi- Disciplinary	3	0	0	3	30(CIA) +70(T)
Any one of the following two Ability Enhancement courses							
BGCAER3 51T	Business Communication I	Ability Enhancement	2	0	0	2	15(CIA) + 35(T)
BGCAER3 52T/ BGCAER3 53T	Modern Indian Language I (Bengali/Hindi)	Ability Enhancement	2	0	0	2	15(CIA) +35(T)
BSDSER3 61P	Python	Skill Enhancement	0	3	0	3	30(CIA) + 70(P)
Total						20	

Semester-IV							
Number of Papers: 6							
Course Code	Course Title	Course Type	Credits in each course				
			Theory	Practical	Tutorial	Credits	
	Statistical Inference-II	Major	3	1	0	4	30(CIA) + 45(T) + 25(P)
	Linear Algebra and Linear Statistical Models	Major	3	1	0	4	30(CIA) + 45(T) + 25(P)
	Multivariate Analysis	Major	3	1	0	4	30(CIA) + 45(T) + 25(P)
	Data Analysis with R	Minor		4		4	30(CIA) + 70(P)
Any one of the following two Ability Enhancement courses							
	Modern Indian Language II (Bengali/Hindi)	Ability Enhance ment	2	0	0	2	15(CIA)+ 35(T)
	Business Communication II	Ability Enhance ment	2	0	0	2	15(CIA)+ 35(T)
	Internship		0	2	0	2	15(CIA) + 35(P)*
Total						20	

***35 = 10(Internal) + 25(External)**

Semester-V							
Number of Papers: 5							
Course Code	Course Title	Course Type	Credits in each course				
			Theory	Practical	Tutorial	Credits	
	Numerical Methods and Optimization Techniques	Major	3	1	0	4	30(CIA) + 45(T) + 25(P)
	Large Sample Theory and Nonparametric Inference	Major	3	1	0	4	30(CIA) + 45(T) + 25(P)
	Regression Analysis	Major	3	1	0	4	30(CIA) + 45(T) + 25(P)
	Statistical Quality Control and Vital Statistics	Major	3	1	0	4	30(CIA) + 45(T) + 25(P)
	Artificial Intelligence	Minor	2	2	0	4	15(CIA) + 35(T)
Total						20	

Semester-VI							
Number of Papers:5							
Course Code	Course Title	Course Type	Credits in each course				
			Theory	Practical	Tutoria l	Credits	
	Statistical Inference-III	Major	3	1	0	4	30(CIA) + 45(T) + 25(P)
	Statistical Decision Theory and Bayesian Inference	Major	3	1	0	4	30(CIA) + 45(T) + 25(P)
	Sample Survey-I and Design of experiments-I	Major	3	1	0	4	30(CIA) + 45(T) + 25(P)
	Time Series Analysis-I and Econometrics-I	Major	3	1	0	4	30(CIA) + 45(T) + 25(P)
	Machine Learning with R/Python	Minor	0	4	0	4	30(CIA) + 70(T)
Total						20	

Program Outcomes

P01 - Critical Thinking: Take informed actions after identifying the assumptions that frame our thinking and actions, checking out the degree to which these assumptions are accurate and valid, and looking at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.

P02 - Effective Communication: Speak, read, write and listen clearly in person and through electronic media in English and in one Indian language, and make meaning of the world by connecting people, ideas, books, media and technology.

P03 - Social Interaction: Elicit views of others, mediate disagreements and help reach conclusions in group settings.

P04- Effective Citizenship: Demonstrate empathetic social concern and equity centered national development, and the ability to act with an informed awareness of issues and participate in civic life through volunteering.

P05 - Ethics: Recognize different value systems including your own, understand the moral dimensions of your decisions and accept responsibility for them.

P06 - Environment and Sustainability: Understand the issues of environmental contexts and sustainable development.

P07 - Self-directed and Life-long Learning: Acquire the ability to engage in independent and life-long learning in the broadest context socio-technological changes.

SEMESTER-I

Course Name: Descriptive Statistics and Probability- I.

Course Type: Discipline Specific Core.

Credit: 4 [Lecture: 3, Practical: 1].

Course Outcomes (CO):

CO1: Familiarize students with collection and presentation of data, use of charts, plots and tables.

CO2: Understanding the measures of central tendency and applying them in practice.

CO3: Understanding the measures of dispersion, measures of skewness and kurtosis and applying them in practice.

CO4: Working with bivariate datasets, applying correlation and regression in practice.

CO5: Develop students' ability to solve combinatorial problems and solve basic problems of probability.

COURSE CONTENT

Module No.	Module Name	Chapter Topic	CO
I	Dataset and its Presentation	Concept of population and sample, Different sources and types of data, Variable and attribute, scales of measurement, Examples of real-life datasets. Frequency distributions, Line chart, Bar diagram, Pie chart, Multiple bar diagram, Leaf and Stem plot, Histogram, Ogive. Frequency polygon, Boxplot and other relevant plots.	CO1
II	Univariate and Bivariate Data	Features of univariate data: Measures of central tendency, Measures of dispersion, Quantiles, Moments, Measures of skewness and kurtosis. Bivariate data: Definition and examples, Scatter plot, Bivariate frequency distribution, Product-moment correlation coefficient and its interpretation, Notion of spurious correlation, Simple linear regression.	CO1, CO2, CO3, CO4
III	Counting and Probability	Introduction, Random experiments, Sample space, Events, Mutually exclusive events, Exhaustive events, Independent events. Definitions of Probability – Classical, Statistical and Axiomatic. Application: Derivation of the probability of at least one event out of n events, $n (>1)$ being finite. Statement of the probabilities of at least m and exactly m out of n events, $n (>m)$ being finite and other examples. Bonferroni inequality, Boole's inequality. The concept of Conditional Probability, theorem of total probability, Bayes theorem and its applications.	CO5

IV	Random Variable and Joint Distribution	Random Variables – discrete and continuous. Concept of the probability distribution of a random variable. Probability Mass and Density functions. Cumulative distribution function (CDF) and the statement of properties of CDF. Illustrations in both discrete and continuous situations. Expectation of random variables, Moments and quantiles. Measures of Central tendency/ Dispersion/ Skewness/ Kurtosis. Discrete and continuous joint distributions. Bivariate probability mass and density functions. Cumulative distributions function (CDF) and properties (statements only). Marginal and conditional distributions. Independence of two random variables. Correlation and Simple Linear Regression.	C05
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Suggested Readings:

Text Books:

1. Goon A.M., Gupta M.K. and Dasgupta B. (2002): *Fundamentals of Statistics, Vol. I*, 8th Edn. The World Press, Kolkata.
2. Rohatgi, V.K. and Saleh, A.K. Md. E. (2015). *An Introduction to Probability and Statistics (3rd Edition)*, Wiley Series in Probability and Statistics, India.

Reference Books:

1. Yule G.U. and Kendall M.G (1994) : *An Introduction to the Theory of Statistics*. 14th Edn. Universal Book stall, Delhi.
2. Hogg, R.V., Tanis, E.A. and Rao J.M. (2009): *Probability and Statistical Inference, Seventh Ed*, Pearson Education, New Delhi.
3. Miller, Irwin and Miller, Marylees (2006): *John E. Freund's Mathematical Statistics with Applications*, (7th Edn.), Pearson Education, Asia.
4. Myer, P.L. (1970): *Introductory Probability and Statistical Applications*, Oxford & IBH Publishing, New Delhi .
5. Ross, S.M. (2014): *A First Course in Probability*, 9th Edn. Pearson, USA.
6. Chung, K.L. (1974): *Elementary Probability Theory with Stochastic Processes*, 3rd Edn. Springer, USA.
7. Goon A.M., Gupta M.K. and Dasgupta B. (2002): *Outline of Statistical Theory, Vol. I*. The World Press, Kolkata.
8. Feller, William. *An Introduction to Probability Theory and Its Applications*. Vol. 1, 3rd ed., John Wiley & Sons, 1968.

9. Uspensky, J. V. *Introduction to Mathematical Probability*. McGraw-Hill, 1937.

10. Parzen, Emmanuel. *Modern Probability Theory and Its Applications*. John Wiley & Sons, 1960.

List of Practicals:

1. Organize a given dataset into a frequency distribution table.
2. Graphical/diagrammatic representation of data.
3. Calculate summary measures such as the mean, median, mode, quantiles, variance, standard deviation, coefficient of variation, etc. for a given dataset. Interpret the results in context.
4. Create a scatter plot for a given bivariate dataset and interpret patterns. Compute the Pearson correlation coefficient and discuss its strength and direction.
5. Fitting of a simple linear regression model. Interpret the slope and intercept in the context of the data. Predict values based on the regression equation and discuss possible spurious correlations.

Teaching Pedagogy:

S. No.	Description	Used (Yes/No)
1	Lecture	Yes
2	Discussion/Demonstration	Yes
3	Case Study	Yes
4	Test/Assignment	Yes
5	Student Seminars/Presentation	Yes

CO-PO mapping:

CO/PO	P01 (Critical Thinking)	P02 (Effective Communication)	P03 (Social Interaction)	P04 (Effective Citizenship)	P05 (Ethics)	P06 (Environment and Sustainability)	P07 (Self-directed and Life-long Learning)
CO1	L	H	H	M			M
CO2	H	M	M				H
CO3	H	M	M				H
CO4	H	M	M				H
CO5	H						H
Avg.	2.6	1.8	1.8	0.4	0	0	2.8

*** **H** means High relevance, **M** means medium relevance, **L** means Low relevance

SEMESTER-I

Course Name: Programming in C/C++.

Course Type: Minor.

Credit: 4 [Lecture: 2, Practical: 2].

Course Outcomes (CO):

CO1: Understanding the fundamental concepts of C programming.

CO2: Develop student's ability to design, implement and debug C programs.

CO3: Familiarize students with essential programming constructs such as variables, control statements and functions.

CO4: Develop students' ability to apply programming skills to compute basic statistical measures.

CO5: Familiarize students with simulation experiments.

COURSE CONTENT

Module No.	Module Name	Chapter Topic	CO
I	Introduction	Overview of C language, Basic Structure, Header Files, Character sets, Keywords, Identifiers, Constants, Variables, Data types (Data types – primitive and non-primitive). Arithmetic, Relational, Logical and Assignment; Increment, Decrement and Conditional, Operator Precedence and Associativity; Expressions, Expression evaluation and type conversion, casts, Formatted input and output. Assignment, Initialization, Decision making, looping and control structure	CO1,CO2
II	Array, String and String handling function, Pointers, Functions, Derived Data Types (Structures and Unions)	One-Dimensional Arrays and Initialization, Two-Dimensional Arrays and Initialization, Accessing array elements. String declaration, Initialization and accessing, Array of Strings, String functions. Declaration and initialization of pointer, accessing variables through pointer, Problems with Pointers. General form of a Function, Function Declaration and Definition, Function Arguments (Call by Value and Call by Reference), Arguments to main() (argc and argv), Returning from a Function, Functions Returning Values and their types, Function Returning Pointers, Functions of Type void, Declaring Variable-Length Parameter Lists, Passing pointer to function, Passing One-Dimensional Arrays to Functions, Passing Two-Dimensional Arrays to Functions, Recursion, Library Functions. Basics of Structures, Accessing Structure Members, Array of Structures, Pointers to Structures, Unions, typedef.	CO2,CO3
III	Descriptive Statistics	Writing C programs to compute measures of central tendency (Mean, trimmed means, median, mode), Quantiles, Measures of dispersion (Range, standard deviation, mean absolute deviation, coefficient of variation), Gini's index. Creating frequency tables. Computing product-moment correlation coefficient. Fitting simple linear regression equation. Real data analysis and interpretation	CO4
IV	Probability	C programs to compute factorials, binomial coefficients. Pseudo-random number generation. Simulation of random experiments to compute probability of an event using the relative frequency	CO5

		approach: Problems related to coin toss, dice rolls etc. Problems on conditional probability and Bayes' Theorem.	
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Suggested Readings:

Text Books:

1. B. S. Gottfried. Programming in C (Schaum's Series).
2. Balaguruswami. Programming in ANSI C- E (TMH).

Reference Books:

1. B. W. Kernighan and D. M. Ritchie. The C Programming Language (PHI).
2. H. Schildt. C Made Easy (McGraw-Hill).
3. Pradip Dey and Manas Ghosh. Computer Fundamentals and Programming in C, Second Edition (Oxford University Press).
4. Ajay Mittal. Programming in C: A Practical Approach (Pearson Publication).
5. Sheldon M. Ross. Simulation, Fifth Edition (Academic Press Inc).

Teaching Pedagogy:

S. No.	Description	Used (Yes/No)
1	Lecture	Yes
2	Discussion/Demonstration	Yes
3	Case Study	Yes
4	Test/Assignment	Yes
5	Student Seminars/Presentation	Yes

CO-PO mapping:

CO/PO	P01 (Critical Thinking)	P02 (Effective Communication)	P03 (Social Interaction)	P04 (Effective Citizenship)	P05 (Ethics)	P06 (Environment and Sustainability)	P07 (Self-directed and Life-long Learning)
CO1	H	H			M		H
CO2	H	H			M		H
CO3	H	H			M		H
CO4	H	H	M	L			H
CO5	H	H	M	L			H
Avg.	3	3	0.8	0.4	1.2	0	3

*** **H** means High relevance, **M** means medium relevance, **L** means Low relevance

SEMESTER-I

Course Name: Introduction to Economic Theory.

Course Type: Multi-Disciplinary Course.

Credit: 3 [Lecture: 3]

Course Outcomes (CO):

CO1: The students will be able to recognize the basic theories of how individuals and firms interact within markets.

CO2: The students will be able to understand and analyse the broad macroeconomic issues in a structured manner.

CO3: The students will be able to understand the fundamental theories and challenges of an open economy.

CO4: The students will be equipped with the tools to analyse the practical economic issues both at the domestic and the international level.

CO5: The students will be able to evaluate and apply economic models and concepts to real-world policy problems, assessing their implications for both public and private decision-making.

Course Content:

Module No.	Module Name	Chapter Topic	CO
I	Microeconomic Foundations	How Market Works; Concept of Elasticity; Consumer and Producer Behaviour; Market Structure	CO1, CO4
II	Macroeconomic Foundations	National Income Accounting; Theories of Income Determination; Aggregate Demand and Aggregate Supply; Inflation and Unemployment	CO2, CO4
III	Foundations of International Economics	Comparative Advantage and Gains from Trade; Balance of Payments; Exchange Rate; Fiscal and Monetary Policy in an Open Economy	CO3, CO4, CO5

Suggested Readings:

Hubbard, G., Garnett, A., & Lewis, P. (2019). Essentials of Economics, 5th edition, Pearson Higher Education AU

Lipsey, R. G., & Chrystal, K. A. (2015). Economics, 13th Edition, OUP

Mankiw, N.G. (2016). Macroeconomics, (9th ed.). Worth Publishers. New York.

Samuelson, P., & Nordhaus, W. (2009). Economics. McGraw Hill.

Sloman, J., & Garratt, D. (2016). Essentials of Economics, 7th edition, Pearson

Teaching Pedagogy:

S. No.	Description	Used (Yes/No)
1	Lecture	Yes
2	Discussion/Demonstration	Yes
3	Case Study	Yes
4	Test/Assignment	Yes
5	Student Seminars/Presentation	Yes

CO-PO mapping:

CO/PO	P01 (Critical Thinking)	P02 (Effective Communication)	P03 (Social Interaction)	P04 (Effective Citizenship)	P05 (Ethics)	P06 (Environment and Sustainability)	P07 (Self-directed and Life-long Learning)
C01	M	M	H	M			M
C02	M	M		M			M
C03	M	M		M			M
C04	H	H	M	L			H
C05	H	M					H
Avg.	2.4	2.2	1	1.4	0	0	2.4

*** **H** means High relevance, **M** means medium relevance, **L** means Low relevance

SEMESTER-I

Course Name: Cyber Law and IPR.

Course Type: Multi-Disciplinary Course.

Credit: 3 [Lecture: 3].

Course Outcomes (CO):

CO1: Remembering the preliminary techniques involved with the computer system providing communications and its multiple applications in contemporary society.

CO2: Understanding role of electronic means of communications in the formation of the contracts and its global acceptance, and generation of information and filing to the government's agencies.

CO3: Analyzing legal aspects of e-contracts, E-signatures, and Statutory authorities in India and modifications in Banking and Penal and Procedural laws.

CO4: Examining issues and challenges pose by the cyberspace to the contemporary society, defining rights, contraventions and their enforcement mechanisms.

CO5: Appraising the legal aspects of intellectual property rights creation and its modification in contemporary society.

COURSE CONTENT

Module No.	Module Name	Chapter Topic	CO
I	Fundamentals of Cyber Space and Cyber Law	Computer and Cyberspace applications in society, An alternative to paper-based communications, Data and Privacy, E-commerce - Signature- Records, Development of Cyber law in India, Objectives, Cybercrimes, Intellectual Property, E-governance	CO1
II	E-commerce and Digital Signature	UNCITRAL Model Law on E-commerce and Signature Formation of contracts, signature, records, E-commerce, Types, Legal aspects of E-commerce, Digital Signature and Multiple applications of E-records in E-taxation, banking and payment, Document Filing with Govt. Agencies, Controller and Certifying Authority	CO2, CO3 & CO4

III	Penalties, Compensation and Adjudication of Cyber Crimes	Traditional Crimes and Cybercrime, Computer related offences, Issues with the Jurisdictions, Phishing, Cyber theft, Cyber Stalking, Cyber Terrorism, Obscenity and Child Pornography in Cyberspace, Adjudicating Office and Cyber Appellate Tribunal, Admissibility of E-evidence	CO3 & CO4
IV	Intellectual Property and Cyber Law	Meaning, Nature and Concept of Intellectual Property Rights, Creation and Protection of Copyright, Domain Name, Copyright in the Digital Medium, Computer Programmes, Copyright and WIPO Treaties and Trademark in cyberspace, Jurisdiction in Trademark Disputes,	CO5

Suggested Readings

1. Vakul Sharma, Information Technology- Law and Practice, Universal Law Publishing Co., 2019
2. Justice Yatindra Singh, Cyber Laws, Universal Law Publishing Co, New Delhi, (2012).
3. Verma S, K, Mittal Raman, Legal Dimensions of Cyber Space, Indian Law Institute, New Delhi, (2004).
4. Pavan Duggal, Cyber Law- An exhaustive section wise Commentary on the Information Technology Act along with Rules, Regulations, Policies, Notifications etc., Universal Law Publishing, 2017.
5. S. R. Bhansali, Information Technology Act, 2000, University Book House Pvt. Ltd., Jaipur (2003).
6. Nandan Kamath, Law relating to Computers Internet and E-commerce, Universal Law Publishing Company, 2016
7. The Information Technology Act, 2002 and Rules
8. Apar Gupta , Commentary on Information Technology Act- With Rules, Regulations, Orders, Guidelines, Reports And Policy Documents, Lexis Nexis , 2015.

Web Links:

< <https://cca.gov.in/about.html> >

< <https://www.mca.gov.in/MinistryV2/certifyingauthorities.html> >

Teaching Pedagogy:

S. No.	Description	Used (Yes/No)
1	Lecture	Yes
2	Discussion/Demonstration	Yes
3	Case Study	Yes
4	Test/Assignment	Yes
5	Student Seminars/Presentation	Yes

CO-PO mapping:

CO/PO	P01 (Critical Thinking)	P02 (Effective Communication)	P03 (Social Interaction)	P04 (Effective Citizenship)	P05 (Ethics)	P06 (Environment and Sustainability)	P07 (Self-directed and Life-long Learning)
C01		H	M	H	M		M
C02	M	H	M	H	M		M
C03	M				M		M
C04	H	H	H	H	M		M
C05	H	M	M		M		M
Avg.	2	2.2	1.8	1.8	2	0	2

*** **H** means High relevance, **M** means medium relevance, **L** means Low relevance

SEMESTER-I

Course Name: Communicative English I.

Course Type: Ability Enhancement Course.

Credit: 2 [Lecture: 2].

Course Outcomes (CO):

CO1: To make the students understand communicative competence. To demonstrate his/her verbal and non-verbal communication ability.

CO2: To make the students analyze and conduct independent surveys, collect data, prepare and present reports and projects.

CO3: To apply effective business correspondence with brevity and clarity. Learn the process of acquiring a job with special reference to prepare a resume.

CO4: To evaluate the process of writing error free while making an optimum use of vocabulary & grammar leading to lifelong learning

CO5: To create and enhance employability and prepare students for the challenges they face while communicating in English in any workspace.

COURSE CONTENT

Module No.	Module Name	Chapter Topic	CO
I	Theory & Grammar	Theory of Communication: Fundamentals, Process of Communication, Types of Communication, Mis-communication, Skills Required for Effective Communication Accurate Grammatical Usage: Sentence Structure, Verbs (Classification), Infinitive & Gerund, Tense, Voice, Phrasal Verbs & Idioms, Punctuation marks.	CO1
II	English Composition	Composition: Reflective, Descriptive, Narrative, Argumentative Summarising Précis Article Writing Blog Writing Documenting and Note-Making	CO2, CO3 & CO4
III	Speaking	Personal Interview, Mock Interview Public Speaking, Presentations	CO3 & CO4

Suggested Readings

1. Fluency in English - Part II, Oxford University Press, 2006.
2. Business English, Pearson, 2008.
3. Language, Literature and Creativity, Orient Blackswan, 2013.
4. A Practical English Grammar, A.J. Thomson, A.V. Martinet, Oxford University Press
5. A Handbook of English Grammar and Usage, D. Thakur, Bharati Bhawan Publication
6. Function in English- Jon Blundell et al, OUP
7. Oxford Practice Grammar, John Eastwood, Oxford University Press

Teaching Pedagogy:

S. No.	Description	Used (Yes/No)
1	Lecture	Yes
2	Discussion/Demonstration	Yes
3	Case Study	Yes
4	Test/Assignment	Yes
5	Student Seminars/Presentation	Yes

CO-PO mapping:

CO/PO	PO1 (Critical Thinking)	PO2 (Effective Communication)	PO3 (Social Interaction)	PO4 (Effective Citizenship)	PO5 (Ethics)	PO6 (Environment and Sustainability)	PO7 (Self-directed and Life-long Learning)
CO1	H	H					
CO2		H	H				
CO3							H
CO4		M	H				H
CO5				L			H
Avg.	0.6	1.6	1.2	0.2			1.8

*** **H** means High relevance, **M** means medium relevance, **L** means Low relevance

SEMESTER-I

Course Name: Personality Development.

Course Type: Skill Enhancement Course.

Credit: 3 [Lecture: 3].

Course Outcomes (CO):

CO1: Identify strengths, weaknesses, opportunities and challenges related to their personal capabilities for effectively managing conflict and stress.

CO2: Understand life skills as a perfect blend of knowledge and behavior, attitudes and work ethics to respond effectively to demands and challenges of daily life.

CO3: Apply group dynamic techniques in the context of organizational culture to gain a deeper understanding of how to make team building more pro-active and efficient.

CO4: Evaluate inter-personal relations and analyze the barriers to effective communication.

CO5 Develop a leadership style that is uniquely theirs by effectively using their soft skills.

COURSE CONTENT

Module No.	Module Name	Chapter Topic	CO
I	Personality & Personality Development: Fundamentals	Define Personality & Why Personality Development? Determinants of Personality Development Types of Personality (including activities)	CO1
II	Self-Management	Motivation Conflict Management Time Management Stress Management (including activities)	CO1, CO2
III	Social Skill Development	Inter-personal Relations & Communication Group Dynamics Team Building Leadership Holistic Well-being (including activities)	CO3, CO4, CO5

Suggested Readings

1. Mukherjee, S. (2021). *Personality Development Studies for Leadership: Foundation Course*. St. Xavier's University, Kolkata (1st ed.).
2. Agarwal, R. & Tandon, A. (2012). *Personality Development & Leadership*. Oxford Book Company (1st ed.).
3. Mitra, B. K. (2016). *Personality Development And Soft Skills*. Oxford University Press, India (2nd ed.).

Additional Readings

1. Hurlock, E. B. (2017). *Personality Development*. Tata McGraw Hill, New Delhi (Indian Edition).
2. Onkar, R. M. (2014). *Personality Development and Career Management: A Pragmatic Perspective*.
3. S. Chand Publishing, New Delhi (3rd revised ed.).
4. Gallagher, K. (2010). *Skills Development*. Oxford University Press, India (Indian Edition).
5. Mangal, S.K. (2018). *Educational Psychology*. Tondon Publications, Ludhiana.
6. Morgan, C. & King, R. (2017). *Introduction To Psychology*. McGraw Hill Education - 7th ed. (Indian Edition).

Teaching Pedagogy:

S. No.	Description	Used (Yes/No)
1	Lecture	Yes
2	Discussion/Demonstration	Yes
3	Case Study	Yes
4	Test/Assignment	Yes
5	Student Seminars/Presentation	Yes

CO-PO mapping:

CO/PO	PO1 (Critical Thinking)	PO2 (Effective Communication)	PO3 (Social Interaction)	PO4 (Effective Citizenship)	PO5 (Ethics)	PO6 (Environment and Sustainability)	PO7 (Self-directed and Life-long Learning)
CO1	M		M		H		H
CO2	H	M	H	M	H	M	H
CO3	H	H	H	M	H		M
CO4		H	H	M	M		H
CO5	H	H	H	H	H	H	H
Avg.	2.2	2.2	2.8	1.8	2.8	1	2.8

*** **H** means High relevance, **M** means medium relevance, **L** means Low relevance

SEMESTER-I

Course Name: Interreligious Studies for Global Citizenship.

Course Type: Common Value-Added Course.

Credit: 2 [Lecture: 2].

Course Outcomes (CO):

CO1: Identify the value system in different religions and understand their basic philosophy required for global citizenship.

CO2: Understand the meaning of spirituality.

CO3: Analyze the morals and ethics in different religious scriptures and learn from the life stories of Gurus, Mystics, Saints and Philosophers.

CO4: Explain the need for inter-religious dialogue and apply the same in relation to social change.

CO5 Develop an attitude of care and empathy for all and the environment.

COURSE CONTENT

Module No.	Module Name	Chapter Topic	CO
I	Academic Study of Religion	Religion, a Global Human Activity Religion in Indian Education System Essentials of Religion and Spirituality	CO1, CO2
II	The Global Religious Landscape	Hinduism Islam Christianity Buddhism Jainsim Sikhism Zoroastrianism	CO1, CO2, CO3
III	Religious Pluralism and Dialogue	Rationale for Global Spread of Religious Diversity The Importance of Inter- religious Dialogue for Global Citizenship Different Kinds of Dialogue	CO4
IV	Reflections		CO5

Suggested Readings

1. Romus, D. John (2023). *Religious Studies for Global Citizenship: Foundation Course*, St. Xavier's University, Kolkata.
2. Kassam, M. (Ed.). (2017). *The Religions of India : A Microcosm of World Religions*. Manohar Publications, India.
3. Gaus, R. (2021). Global (Citizenship) Education as inclusive and diversity learning in Religious Education. *Journal of Religious Education*, 69(2), 179-192.
4. Alles D., Gregory (2010). *Religious Studies: A Global View*. Routledge, UK (1st ed.).
5. Dalal, R. (2014). *The Religions of India: A Concise Guide to Nine Major Faiths*. Penguin, India.
6. Cavallin, C., Sander, Å., Sitharaman, S. (2020). *The Future of Religious Studies in India*. Routledge, India (1st ed.).
7. Raj S.J., J. Felix (2022). *Tides: Story Bank*. St. Xavier's University Kolkata Alumni Association, Kolkata.
8. Kolkata.
9. Raj S.J., J. Felix (2020). *Waves: Story Bank*. St. Xavier's University Kolkata Alumni Association, Kolkata.

Teaching Pedagogy:

S. No.	Description	Used (Yes/No)
1	Lecture	Yes
2	Discussion/Demonstration	Yes
3	Case Study	Yes
4	Test/Assignment	Yes
5	Student Seminars/Presentation	Yes

CO-PO mapping:

CO/PO	PO1 (Critical Thinking)	PO2 (Effective Communication)	PO3 (Social Interaction)	PO4 (Effective Citizenship)	PO5 (Ethics)	PO6 (Environment and Sustainability)	PO7 (Self-directed and Life-long Learning)
CO1	M		H	H	H		H
CO2	H		H	H			H
CO3	M		H	H	H		H
CO4	M	M	H	H			H
CO5			H	H	M	H	H
Avg.	1.8	0.4	3	3	1.6	0.6	3

*** **H** means High relevance, **M** means medium relevance, **L** means Low relevance

SEMESTER-I

Course Name: Environmental Education.

Course Type: Common Value-Added Course.

Credit: 2 [Lecture: 2].

Course Outcomes (CO):

CO1: Recognize the historical context of human interactions with the environment and resources that sustain life and govern economy.

CO2: Understand the concept of natural resources; identify types of natural resources, their distribution and use with special reference to India. Also to understand the major international institutions and programmes and the role played by them in the protection and preservation of the environment.

CO3: Analyze the morals and ethics in different religious scriptures and learn from the life stories of Gurus, Mystics, Saints and Philosophers.

CO4: Determine the root cause of various pollution, its impact on human health and the consequences of species extinction.

CO5 Support sustainability as a practice in life, society, and industry.

COURSE CONTENT

Module No.	Module Name	Chapter Topic	CO
I	Humans and the Environment	1.1 Multidisciplinary nature of environmental studies; Scope and importance of Environment study 1.2 The man-environment interaction: Humans as hunter-gatherers; Origin of agriculture; Emergence of city-states; Great ancient civilizations and the environment; Industrial revolution and its impact on the environment 1.3 Human population growth: Impacts on environment and its control; Global Environment change (Major Reason) 1.4 The emergence of environmentalism: Anthropocentric and eco-centric perspectives (Brief idea) UN Conference on Human Environment 1972; The Club of Rome- Limits to Growth; Rio Summit	CO1

II	Natural Resources, Local, Regional and Global Environmental Issues and Sustainable development	2.1 Definition and classification of resource 2.2 Biotic Resources: Forest, Grassland, Desert, Aquatic ecosystems; Status and challenges 2.3 Water: Use and over-exploitation of surface and ground water, Environmental impact Conflicts over water Water conservation 2.4 Minerals: Important minerals; Mineral exploitation; Environmental problems due to extraction of minerals 2.5 Energy resource: Renewable (Cochin Airport, Muppandal Wind Park) and non-renewable energy sources; Implications of energy use on the environment 2.6 Land use and Land cover change: Land degradation, soil erosion, deforestation, desertification and urbanization. 2.7 Global change: Global warming, Ozone layer depletion, Acid rain and Photo-chemical smog 2.8 Introduction to sustainable development: World Commission on Environment and Development and Concept of Sustainable development, Sustainable Development Goals (SDGs)- targets and indicators, challenges and strategies for SDGs	CO1, CO5 CO1 CO2, CO3, CO4
III	Biodiversity Conservation and Ecosystem	3.1 Ecosystems and ecosystem services: Structure and function of ecosystem; Energy flow in an ecosystem; Food chains and food webs, Ecological Pyramid, Succession and Interaction; Ecosystem values: ecological, economical, social, ethical, aesthetic values 3.2 Biodiversity and its distribution: Levels and types of biodiversity; Biodiversity hotspots; Threats to biodiversity and ecosystems Conservation of biodiversity: <i>In-situ</i> and <i>Ex-situ</i> conservation; Major protected areas; National and International Instruments for biodiversity conservation; the role of traditional knowledge, community-based conservation	CO2

IV	Environmental pollution and Climate Change Impacts, Adaptation, Mitigation and public health	4.1 Understanding pollution: Production processes and generation of wastes; Assimilative capacity of the environment; Point sources and non-point sources of pollution. 4.2 Air pollution: Indoor air pollution; Adverse health impacts of air pollutants; National Ambient Air Quality Standards. 4.3 Water pollution: Sources of water pollution Water quality parameters and standards; adverse health impacts of water pollution on human and aquatic life. 4.4 Soil pollution and solid waste 4.5 Noise pollution: Noise standards; adverse impacts of noise on human health. 4.6 Pollution Disaster: Bhopal Gas Tragedy, Minamata Disease 4.7 Understanding climate change: Natural variations in climate; Causes and Impacts of Climate change • 4.8 Mitigation of climate change: carbon neutrality;	CO ₂ , CO ₄
	Environmental Treaties and Management	5.1 Major International Environmental Agreements: Convention on Biological Diversity (CBD); Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES); Ramsar Convention on Wetlands of International Importance 5.2 Environmental legislation in India (Brief Idea): Wildlife Protection Act (1972), Water (Prevention and control of Pollution) Act (1974), Forest Conservation Act (1980), Air (Prevention & Control of Pollution) Act (1981), Environment Protection Act (1986) • 5.3 Practices- Earth Hour; EIA (advantages, and disadvantages)	CO ₂

Suggested Readings

1. Basu, M. and Xavier, S., *Fundamentals of Environmental Studies*, Cambridge University Press, 2016.
2. Mitra, A. K and Chakraborty, R., *Introduction to Environmental Studies*, Book Syndicate, 2016.
3. Fisher, M. H., *An Environmental History of India- From Earliest Times to the Twenty-First Century*, Cambridge University Press, 2018.
4. Gadgil, M., and Guha, R., *This Fissured Land: An Ecological History of India*. Univ. of California Press, 1993.
5. Gleeson, B. and Low, N. (eds.), *Global Ethics and Environment*, London, Routledge, 1999.
6. Harris, F. Global Environmental Issues, 2nd Edition. Wiley- Blackwell, 2012.
7. Bawa, K.S., Oomen, M.A. and Primack, R., *Conservation Biology: A Primer for South Asia*. Universities Press, 2011.
8. Krishnamurthy, K.V., *Textbook of Biodiversity*, Science Publishers, Plymouth, UK, 2003.
9. Ahluwalia, V. K., *Environmental Pollution, and Health*. The Energy and Resources Institute (TERI), 2015.

Teaching Pedagogy:

S. No.	Description	Used (Yes/No)
1	Lecture	Yes
2	Discussion/Demonstration	Yes
3	Case Study	Yes
4	Test/Assignment	Yes
5	Student Seminars/Presentation	Yes

CO-PO mapping:

CO/PO	P01 (Critical Thinking)	P02 (Effective Communication)	P03 (Social Interaction)	P04 (Effective Citizenship)	P05 (Ethics)	P06 (Environment and Sustainability)	P07 (Self-directed and Life-long Learning)
CO1						M	
CO2						M	
CO3						M	
CO4						M	
CO5						M	L
Avg.						2	0.2

*** **H** means High relevance, **M** means medium relevance, **L** means Low relevance

SEMESTER-II

Course Name: Descriptive Statistics and Probability- II.

Course Type: Discipline Specific Core.

Credit: 4 [Lecture: 3, Practical: 1].

Course Outcomes (CO):

CO1: To aware about the foundational concepts of bivariate data analysis

CO2: To make the students acquainted with the foundational concepts of probability theory, laws and theorems.

CO3: Computing and interpreting expectations, moments, and generating functions

CO4: To identify and utilize different types of random variables and their distributions

CO5: To apply knowledge of standard probability distributions in real-world scenarios.

COURSE CONTENT:

Module No.	Module Name	Chapter Topic	CO
I	Descriptive Statistics II	Bivariate and multivariate data, Curve fittings and orthogonal polynomials, correlation ratio, correlation index, intraclass correlation, rank correlation: Spearman's and Kendall's measures. Multiple and partial correlation and regression.	CO1, CO2, CO3
II	Analysis of categorical data	Contingency table, Consistency of data, independence, and association of attributes. Measures of association - Yule's, Pearson's and Goodman-Kruskal's coefficients, Idea of Odds Ratio, Binary response and logistic regression.	CO1, CO4
III	Generating Functions	Generating function, probability generating function, moment generating function, cumulant generating function and characteristic function. Conditional mean and variance.	CO2, CO3, CO4
IV	Discrete and Continuous Probability Distributions	Discrete Probability Distributions: Uniform, Bernoulli, Binomial, Poisson, Geometric, Negative Binomial, Hypergeometric. Continuous Probability Distributions: Uniform, Exponential, Cauchy, Beta, Gamma, Normal, Lognormal.	CO2, CO3, CO4, CO5

Reference Books:

1. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2002): Fundamentals of Statistics, Vol. I, 8th Edn. The World Press, Kolkata
2. Goon, A.M., Gupta, M.K. & Dasgupta, B. (1994): An Outline of Statistical Theory (Vol-1), World Press
3. Rohatgi, V. K. and Saleh, A.K. Md. E. (2009): An Introduction to Probability and Statistics. 2nd Edn. (Reprint) John Wiley and Sons.

Suggested Readings:

1. Hogg, R.V. & Craig, A.T. (2002):- Introduction to Mathematical Statistics. Pearson Education India
2. Rohatgi, V.K. (1975):- An Introduction to the Theory of Probability and Mathematical Statistics
3. W. Feller: Introduction to Probability: Theory and Applications - Vol. I and II.
4. J. Pitman: Probability.
5. Sheldon Ross: Probability Models.
6. P. G. Hoel, S. C. Port and C. J. Stones: Introduction to Probability Theory.
7. K. L. Chung: Elementary Probability Theory with Stochastic Processes.
8. R. Meester: A Natural Introduction to Probability Theory.
9. Miller, Irwin and Miller, Marylees (2006): John E. Freunds Mathematical Statistics with Applications, (7th Edn.), Pearson Education, Asia.
10. 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.
11. Tukey, J.W. (1977): Exploratory Data Analysis, Addison-Wesley Publishing Co.
12. Santosh S. Venkatesh: Theory of Probability - Explorations and Applications.
13. Parzen, E. (1972): Modern Probability Theory and its Applications, John Wiley.
14. Uspensky, J.V. (1937): Introduction to Mathematical Probability, McGraw Hill.
15. Cacoullos, T. (1973): Exercises in Probability, Narosa.
16. Rahman, N.A. (1983): Practical Exercises in Probability and Statistics, Griffin.
17. Ross, S. (2002): A First Course in Probability, Prentice Hall.
18. Hogg, R.V., Tanis, E.A. and Rao J.M. (2009): Probability and Statistical Inference, Seventh Ed, Pearson Education, New Delhi.
19. Myer, P.L. (1970): Introductory Probability and Statistical Applications, Oxford & IBH Publishing, New Delhi.

List of Suggested Practical:

1. Problems based on the analysis of bivariate data.
2. Rank correlation.
3. Partial and multiple correlations.
4. Problems based on analysis of categorical data.

5. Fitting of discrete and continuous distributions.
6. Problems based on area and the ordinate for a specified area for normal distribution with application

Teaching Pedagogy:

S. No.	Description	Used (Yes/No)
1	Lecture	Yes
2	Discussion/Demonstration	Yes
3	Case Study	Yes
4	Test/Assignment	Yes
5	Student Seminars/Presentation	Yes

CO-PO mapping:

CO/PO	P01 (Critical Thinking)	P02 (Effective Communication)	P03 (Social Interaction)	P04 (Effective Citizenship)	P05 (Ethics)	P06 (Environment and Sustainability)	P07 (Self-directed and Life-long Learning)
CO1	L	H	H	M			M
CO2	H	M	M				H
CO3	H	M	M				H
CO4	H	M	M				H
CO5	H						H
Avg.	2.6	1.8	1.8	0.4			2.8

*** **H** means High relevance, **M** means medium relevance, **L** means Low relevance

SEMESTER-II

Course Name: Data Structures and Algorithms using C/C++

Course Type: Minor.

Credit: 4 [Lecture: 2, Practical: 2].

Course Outcomes (CO):

CO1: Understanding the fundamental concepts of data, data types, and abstract data types.

CO2: Implementation of different abstract data types using various data structures.

CO3: Applying different types of data structures to implement various application problems.

CO4: Understanding and implementing different searching and sorting techniques.

CO5: Analyzing the suitability and compatibility of different data structures based on application types.

COURSE CONTENT

Module No.	ModuleName	ChapterTopic	CO
I	Introduction	Problem solving through computer, Design of algorithm to solve a problem, Concept of static and dynamic memory allocation, Algorithms and data structures, Concept of Abstract Data Type (ADT) with examples Efficiency of an algorithm, Asymptotic notations, Time and space complexities, Analysis of algorithms, Comparing asymptotic running times, Impact of data structure on the performance of an algorithm	CO1
II	Array, Stack,	Array, Single and multi-dimensional array, Memory representation (row major and column major) of array, Insertion and deletions in array, Advantages and disadvantages of array Stack as an ADT, Main operations (push and pop), auxiliary operations and axioms, Array implementation of stack, Limitation of array implementation, Linked list implementation of stack, Applications of stack: Recursion, Function call, Evaluation of postfix expression using stack, Conversion of infix to postfix using stack.	CO2
III	Queue, Tree	Queue as an ADT, Main operations (enqueue and dequeue), Auxiliary operations and axioms, Array implementation of queue, Limitation of array implementation and Circular queue, Linked list implementation of queue, Double ended queue (dequeue) Priority queue and its applications Binary Tree, Definition and properties, Representation of binary tree in memory: linked representation, array representation, Binary tree traversal, Preorder, Inorder and Postorder, Expression tree, Heap and its applications, Binary search tree, Balanced binary search tree, AVL tree, RedBlack tree, M-way tree, M-way search tree, B tree, B+ Tree	CO3
IV	Searching and Sorting	Linear search and binary search. Bubble, selection, insertion, Quick sort, Merge sort, Heap	CO4

		sort, Radix sort	
V	Graphs and Hashing	Mathematical Properties, Degree, Connectedness, Representation using matrix, Adjacency list, Directed Graphs, Directed Acyclic Graph Hash functions. Collision, Collision resolution techniques: linear probing, quadratic probing, double hashing, chaining, Rehashing	CO5

Suggested Readings:

Text Books:

1. R. F. Gilberg and B. A. Forouzan, "Data Structures: A pseudocode approach with C", 2nd Edition, CENGAGE Learning.
2. A. V. Aho, J. D. Ullman and J. E. Hopcroft, "Data Structures and Algorithms", Addison Wesley.
3. Lipschutz, "Data Structures (Schaum's Outline Series)", Tata Mcgraw Hill.
4. E. Horowitz, S. Sahni, S. Anderson-Freed, "Fundamentals of Data Structures in C", Universities Press; Second edition (2008).

Reference Books:

1. Y. Langsam, M. J. Augenstein and A. N. Tanenbaum, "Data Structures using C and C++", Pearson, 2006.
2. Knuth, Donald E. The Art of Computer Programming. 3rd ed. Vols 1&2. Reading, MA: Addison-Wesley, 1997. ISBN: 0201896834. ISBN: 0201896842. ISBN: 0201896850.
3. Kleinberg and Eva Tardos. Algorithm Design. Addison-Wesley 2005 ISBN-13: 978-0321295354.

Teaching Pedagogy:

S. No.	Description	Used (Yes/No)
1	Lecture	Yes
2	Discussion/Demonstration	Yes
3	Case Study	No
4	Test/Assignment	Yes
5	Student Seminars/Presentation	Yes

CO-PO mapping:

CO/PO	P01 (Critical Thinking)	P02 (Effective Communication)	P03 (Social Interaction)	P04 (Effective Citizenship)	P05 (Ethics)	P06 (Environment and Sustainability)	P07 (Self-directed and Life-long Learning)
CO1	L	H	H	M			M
CO2	H	M	M				H
CO3	H	M	M				H
CO4	H	M	M				H
CO5	H						H
Avg.	2.6	1.8	1.8	0.4			2.8

*** **H** means High relevance, **M** means medium relevance, **L** means Low relevance

SEMESTER-II

Course Name: Introduction to Development Studies

Course Type: Multi-Disciplinary Course.

Credit: 3 [Lecture: 3]

Course Outcomes (CO):

CO1: Students will be able to understand the notion of economic development and its difference with the concept of growth.

CO2: Students will be able to understand the issues of structural transformation in less developed economies.

CO3: Students will be able to understand the concept of human development, poverty, inequality and learn to develop commonly used human development, inequality and poverty indices.

CO4: Students will be able to analyze the problems of development and ways to overcome underdevelopment.

CO5: Students will be able to critically assess the role of institutions, governance, and policies in promoting or hindering economic development in less developed economies.

COURSE CONTENT

Module No.	Module Name	Chapter Topic	CO
1.	Growth and Development	Growth vs development. Is per-capita income a good measure of development? Growth & Development in India. Commodities vs Capabilities. Low Level Equilibrium Trap and Big Push, Vicious Cycle of Poverty.	CO1, CO4
2.	Poverty and Inequality	Poverty: measures and indices. Absolute and Relative Poverty, Poverty Line. Inequality: Measurement and indices. Horizontal and Vertical Inequality, Axiomatic Approach to Measuring Poverty and Inequality: Multidimensional measures	CO3
3.	Human Development & Sustainable Development	From income to multi-dimensional measure of development--Human Development Index, Gender Development Index, Inequality Adjusted Human Development Index, The Planetary Pressures--Adjusted Human Development Index. Issues of Sustainability: Sustainable Development Goals.	CO3,CO4, CO5

Suggested Readings:

1. Dutt, A. K. (2014). *Pathways to economic development*. OUP Catalogue.

2. Ray, D. (1998). *Development economics*. Princeton University Press.
3. Sen, Amartya (2001). *Development as freedom (2nd ed.)*. Oxford New York: Oxford University Press.
4. Haq, M. U. (1991). Human development report 1991.
5. Klugman, J. (2011). Human Development Report 2011. Sustainability and Equity: A better future for all. *Sustainability and Equity: A Better Future for All (November 2, 2011)*. UNDP-HDRO Human Development Reports.
6. Basu, K. (2000). On the goals of development. *Frontiers of development economics: The future in perspective*, 61-86.

Teaching Pedagogy:

S. No.	Description	Used (Yes/No)
1	Lecture	Yes
2	Discussion/Demonstration	Yes
3	Case Study	No
4	Test/Assignment	Yes
5	Student Seminars/Presentation	Yes

CO-PO mapping:

CO/PO	P01 (Critical Thinking)	P02 (Effective Communication)	P03 (Social Interaction)	P04 (Effective Citizenship)	P05 (Ethics)	P06 (Environment and Sustainability)	P07 (Self-directed and Life-long Learning)
CO1	M	M	H	M			M
CO2	M	M		M			M
CO3	M	M		M			M
CO4	H	H	M	L			H
CO5	H			M			H
Avg.	2.4	1.8	1	1.8	0	0	2.4

*** **H** means High relevance, **M** means medium relevance, **L** means Low relevance

SEMESTER-II

Course Name: Principles of Management.

Course Type: Multi-Disciplinary Course.

Credit: 3 [Lecture: 3].

Course Objectives:

CO1: Students can enhance their decision-making and analytical skills, students will need to think critically and strategically about management theories and issues

CO2: Explore different organizational structures, leadership styles, and management approaches relevant to engineering firms.

CO3: Teach students how to develop strategic plans, set objectives, and apply decision-making techniques in engineering projects.

CO4: Students will be required to think critically and strategically about management theories and issues, which will enable them to develop their decision-making and analytical skills.

CO5: Explain the concept, principles, and significance of Total Quality Management in modern organizations.

COURSE CONTENT

Module No	Module Name	Topic(s)	Associated course outcome (CO)
Unit 1:	NATURE AND FUNCTIONS OF MANAGEMENT:	Definition, Nature- Features of Management, Evaluation of Management Theories, Management Functions, Management as a Process, Importance of Management, Management and Administration.	CO1

Unit 2:	Functions And Functional Areas of Management:	Functions of Management : Planning – Concept, Nature, Types, Analysis, Management by objectives; Organization Structure – Concept, Structure, Principles, Centralization, Decentralization, Span of Management; Organizational Effectiveness.	CO1, CO3
		Functional Areas of Management, Managerial Skills, Roles of a Manager, Levels of Management, Management as a Science, an Art and as a Profession.	
Unit 3:	Organization And Organization Structure:	Introduction, Organizational Design, Hierarchical Systems ,	CO2
		Organization Structure, Types of Organization Structure, Formal and Informal Organization, Factors Determining Span of Management, Centralization and Decentralization, Span of control, Understanding authority and responsibility, Principles of Delegation, Authority, Developing a culture of Innovation and performance.	CO2
Unit 4	Managerial Competencies:	Communication, Motivation, Team Effectiveness, Conflict Management, Creativity, Entrepreneurship	CO1, CO2, CO3
		Concept, Nature, Styles of Leadership	CO1, CO2, CO3
		Concept, Nature, Process of Decision making	CO1, CO2, CO3, CO4
Unit 5	Quality Management & Performance Improvement	Concept of TQM, Principles of TQM (Customer Focus, Continuous Improvement, Employee Involvement), TQM Tools & Techniques (Six Sigma, PDCA Cycle, Kaizen), Case Studies of TQM in Businesses.	CO4, CO5

Suggested Reading:

1. Principles of Management, Premvir Kapoor, Khanna Publishing House, New Delhi (2018)
2. A. Aswathapa, Organizational Behaviour, 2010
3. Principles And Practice Of Management, Prasad L M, Sultan Chand & Sons, 2019.

Teaching Pedagogy:

S. No.	Description	Used (Yes/No)
1	Lecture	Yes
2	Discussion/Demonstration	Yes
3	Case Study	No
4	Test/Assignment	Yes
5	Student Seminars/Presentation	Yes

CO-PO mapping:

CO/PO	P01 (Critical Thinking)	P02 (Effective Communication)	P03 (Social Interaction)	P04 (Effective Citizenship)	P05 (Ethics)	P06 (Environment and Sustainability)	P07 (Self-directed and Life-long Learning)
CO1	H	M	M	L			
CO2	H	M	M				M
CO3	H	M	M	L			
CO4	H	M	M	L			
CO5	H	M	M	L			
Avg.	3	2	2	0.8	0	0	0.4

*** **H** means High relevance, **M** means medium relevance, **L** means Low relevance

SEMESTER-II

Course Name: Communicative English II.

Course Type: Ability Enhancement Course.

Credit: 2 [Lecture: 2].

Course Outcomes (CO):

CO1: To understand the basic methods of reading and comprehending a passage to enable students to identify main ideas and draw relevant inferences.

CO2: To analyze the role of communication in a professional and personal space and develop an interactive ability.

CO3: To examine the need to write formal business letters and emails using appropriate vocabulary and develop advanced communication skills

CO4: To evaluate methods of group discussion and mock interviews to prepare the students for real life situations.

CO5: To create effective communicators with the ability to express themselves in the workplace and elsewhere.

COURSE CONTENT

Module No.	Module Name	Chapter Topic	CO
I	Reading Comprehension	A. Skimming and scanning, identifying main ideas, drawing inferences (Related texts should be selected by the concerned faculty member of the department for practicing comprehension skills)	CO1, CO2
II	Business English	A. Role of Communication in the business world - introduction B. Business letters C. Meetings - Writing Notice, Agenda, Minutes D. CV & Cover Letter E. E-mail F. Writing Reports - types (commercial) G. Writing Business Proposal	CO2, CO3 & CO4
III	Soft Skills	A. Skills of listening, speaking, reading & writing in theory. B. Group Discussion: Concept of a Group Discussion/Interview, Types of Group Interviews, Skills Evaluated in a GD, Methods to Adopt in a Group Discussion, Mock Group Discussions	CO3 & CO4

Suggested Reading:

1. Raymond Murphy, Intermediate English Grammar, Cambridge University Press
2. Martin Hewings, Advanced Grammar in Use, Cambridge University Press
3. W. Stannard Allen, Living English Structure (5th Edition), Pearson Publications
4. Sureshkumar and P. Sreehari, Communicative English, E. Orient Blackswan
5. Tony Lynch, Study Listening, Cambridge University Press
6. Jeremy Comfort, Speaking Effectively, Cambridge University Press

Teaching Pedagogy:

S. No.	Description	Used (Yes/No)
1	Lecture	Yes
2	Discussion/Demonstration	Yes
3	Case Study	No
4	Test/Assignment	Yes
5	Student Seminars/Presentation	Yes

CO-PO mapping:

CO/PO	P01 (Critical Thinking)	P02 (Effective Communication)	P03 (Social Interaction)	P04 (Effective Citizenship)	P05 (Ethics)	P06 (Environment and Sustainability)	P07 (Self-directed and Life-long Learning)
CO1	H	H					
CO2	M	H					H
CO3		H	M				H
CO4			M				H
CO5		M	M				M
Avg.	1	2.2	1.2	0	0	0	2.2

*** **H** means High relevance, **M** means medium relevance, **L** means Low relevance

SEMESTER-II

Course Name: Spreadsheet and SPSS

Credit: 3, [Lecture: 0, Practical: 3]

Course Outcomes (CO):

CO1: Understanding different data types and structures

CO2: Learning cell and worksheet operations in spreadsheet

CO3: Making the students acquainted with advanced Spreadsheet functions and tools

CO4: Applying Spreadsheet and SPSS for data visualization,

CO5: Learning evaluation of descriptive statistics using Spreadsheet and SPSS.

COURSE CONTENT

Module No.	Module Name	Chapter Topic	CO
I	Introduction to Spreadsheet	Introduction to Spreadsheet: Entering raw data, types of data, cell position and reference (absolute and relative), Transforming Raw Data to Frequency Table (Discrete, Continuous). Cumulative Frequency Table. Cell Operations: Conditional Formatting; Sorting; Filtering, Custom Filtering; Insert, Delete, Format Cells. Data Tools: Remove Duplicates, Wrapping, Merging, Alignments Splitting Data sheets, Hiding operations.	CO1, CO2
II	Introduction to SPSS	The Data Editor, creating variables and Entering data, Types of variables, assigning values to the variables, Selecting and Sorting Cases, Splitting and Merging Files, Computing and Recoding variable. Transpose of data – insert variables and cases – merge variables and cases.	CO4, CO5
III	Summarisation of data	Measures of central tendency: Arithmetic mean, Geometric mean, Harmonic Mean, Median and Mode Measures of Dispersion: Range, Mean Deviation, Quartile Deviation, Standard Deviation; Skewness and Kurtosis. Bivariate Data: Scatter plots, Karl Pearson's Coefficient of Correlation, Spearman's Rank Correlation, Regression analysis: Simple Linear Regression	CO5
IV	Diagrammatic and graphical representation of data	Pie Diagram, Bar Diagram, Line Diagram, Histogram, Boxplot, Ogive.	CO2, CO3, CO4

Textbooks:

1. Field, A. (2005): Discovering Statistics Using SPSS (Fourth Edition). SAGE Publication.
2. Levine D M, Berenson M L, and Krehbiel T C (2008) Statistics for Managers Using Microsoft Excel, Fifth Edition, Published by Prentice Hal

Suggested Readings:

1. Jeremy J. Foster (2001). Data analysis using SPSS for windows. New edition. Versions 8-10. Sage publications. London.
2. Quirk, T. J., Saccuzzo, D. P., & Wilson, L. R. (2015). Statistics for business and economics: Microsoft Excel manual (13th ed.). Pearson.
3. Albright, S. C., Winston, W. L., & Zappe, C. J. (2016). Data analysis and decision making with Microsoft Excel (5th ed.). Cengage Learning.
4. Triola, M. F. (2017). Elementary statistics using Excel (6th ed.). Pearson.
5. Siegel, A. F., & Shim, J. K. (2017). Schaum's outline of statistics for business and economics: Including Microsoft Excel. McGraw-Hill Education.
6. Cunningham, B.J (2012): Using SPSS: An Interactive Hands-on approach
7. Landau, S. and Everitt, S.L. (2004): A Handbook of Statistical Analyses using SPSS. Chaspman& Hall/CRC
8. Moore, D.S. and McCabe, G.P. and Craig, B.A. (2014): Introduction to the Practice of Statistics, W.H. Freeman 2. Cunningham, B.J (2012): Using SPSS: An Interactive Hands-on approach

List of Suggested Practical:

1. Creating a frequency distribution table
2. Measures of central tendency
3. Measures of Dispersion.
4. Measures of Skewness and Kurtosis.
5. To draw scatter plots for a given bivariate dataset and its interpretation
6. To compute the Karl Pearson's correlation coefficient and its interpretation
7. Fit a simple linear regression model.
8. Determination of the slope and intercept in the context of the data, to predict values based on the regression equation
9. Comparing means- One and two sample t- tests
10. Comparing several means using one way and two- way ANOVA.

Teaching Pedagogy:

S. No.	Description	Used (Yes/No)
1	Lecture	Yes
2	Discussion/Demonstration	Yes
3	Case Study	No
4	Test/Assignment	Yes
5	Student Seminars/Presentation	Yes

CO-PO mapping:

CO/PO	P01 (Critical Thinking)	P02 (Effective Communication)	P03 (Social Interaction)	P04 (Effective Citizenship)	P05 (Ethics)	P06 (Environment and Sustainability)	P07 (Self-directed and Life-long Learning)
C01	H	H					
C02	M	H					H
C03		H	M				H
C04			M				H
C05		M	M				M
Avg.	1	2.2	1.2				2.2

*** **H** means High relevance, **M** means medium relevance, **L** means Low relevance

SEMESTER-II

Course Name: Service Learning.

Course Type: Common Value-Added Course.

Credit: 2 [Lecture: 2].

Course Outcomes (CO):

At the end of this course, students will be able to

CO1: Understand the concept of service learning and University-Community Engagement

CO2: Critically think and identify community problems

CO3: Work more collaboratively with others on various social issues

CO4: Organize, initiate, participate or contribute to community based programmatic interventions

CO5: Demonstrate the ability to reflect on personal experiences and learning outcomes from community engagement and apply these insights to future social responsibility initiatives.

COURSE CONTENT

Sl. No	Topic	Sub-topic	Description	CO
1.	Meaning and Scope of Service Learning and Community Engagement	Concept of Service Learning and Community Engagement	Understanding Service Learning and Community Engagement: Its Philosophy and Purpose, Models of Service Learning: Project Model, Charity Model, Social Justice Model	CO1
2.	Understanding Social Issues and Development	Understanding Social Issues and Development	Understanding Social Issues relating to Poverty and Unemployment, Gender Discrimination, , Health and Nutrition, Climatic Change and Community Resilience, Water and Sanitation, Environmental Concerns, Ageing and elderly Care, Issues of Marginalized sections	CO1, CO2
3	Communication for Development (C4D)	Concept of C4D and its significance in Human Development, Social and Behavioural Change	Theories of Communication, C4D and Human Development, Communication for Social and Behavioural Change, Socio-Ecological Model and Situational Analysis, Design and Implementation of C4D Plan	CO1, CO2
3.	Understanding University-Community Engagement	University-Community Engagement	History of Service Learning in the context of Indian universities Best Practices of University-Community Engagement Jesuit Service Learning in India Initiatives taken by St. Xavier's University, Kolkata for Community Development: A Case Study	CO1, CO2
4.	Field Visits and Institution Visits	Sites for Field Visits	Anganwadi Centres School: Primary and High Schools Health Centres Panchayat Library Youth Club Self-Help Groups Block Development Office Post Office Places of Historical Importance Old Age Home and Child Care Institutions	CO2, CO5

			Institutions for Differently Abled Persons (Divyang) NGO visit Agencies working with concepts relating to SBCC (*Visits should be followed by report writing, presentation and discussion)	
5.	Practices for Service Learning and University-Community Engagement	Practicing Service Learning	In collaboration with community members like Village Panchayats, Parents, Educational Institutions (Heads, Teachers and Students), Anganwadis and Health Centres students will be engaged with any the following types of field based programmatic interventions. - Organizing or participating in awareness generation programme relating to various social issues like early childhood care and nutrition among parents, importance of education and digital literacy among community members, good habits among primary school children, life skills and menstrual hygiene among secondary school students, environmental issues among community members, gender based violence - Supplementary educational support for children in elementary education that includes conducting remedial classes, and providing tutorial support to low performing students, promote joyful teaching and learning methods - Engaging with initiatives/activities relating to skill development and livelihood generation for rural youth	CO3, CO4

			and women through vocational training courses, career counseling, conducting training programmes on soft skills and digital literacy, personality development • Engaging children and adolescent with initiatives relating to Life Skill Education, extracurricular activities like art, dance, singing, initiating plantation drives • Providing services to children, person with special need, elderly persons in institutions and difficult circumstances • Organizing and participating in Health and Blood donation camps, at the community level • Initiating or participating in activities relating to neighborhood learning • Engaging with initiatives relating to Social and Behavioral Change Communication (SBCC)	
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Suggested Readings:

1. Cress, Christine M., Collier, Peter J., Reitenauer, Viki L. (2005). Learning Through Serving: A Student Guidebook for Service Across Disciplines. Sterling Virginia.
2. Jacoby, B. (2010). Service learning in higher education: concepts and practices. Michigan: Jossey-Bass Publishers.
3. Lavery, S., Chambers, D. and Cain, G. (2018). Service Learning: Enhancing Inclusive Education.
4. Speck, B.W., & Hoppe, S.L. (2004). Service-learning: History, Theory and Issues. Connecticut: Greenwood Publishing Group.
5. Communication for Social and Behavioural Change (CSBC) Learning Module Series by unicef .

Teaching Pedagogy:

S. No.	Description	Used (Yes/No)
1	Lecture	Yes
2	Discussion/Demonstration	Yes
3	Case Study	No
4	Test/Assignment	Yes
5	Student Seminars/Presentation	Yes

CO-PO mapping:

CO/PO	PO1 (Critical Thinking)	PO2 (Effective Communication)	PO3 (Social Interaction)	PO4 (Effective Citizenship)	PO5 (Ethics)	PO6 (Environment and Sustainability)	PO7 (Self-directed and Life-long Learning)
CO1	M						
CO2	M	M	M	H	H		
CO3		M	M		H		
CO4		M	M				M
CO5	H						H
Avg.	1.4	1.2	1.2	0.6	1.2		1

*** **H** means High relevance, **M** means medium relevance, **L** means Low relevance

SEMESTER-II

Course Name: Understanding Indian Constitution.

Course Type: Common Value-Added Course.

Credit: 2 [Lecture: 2].

Course Outcomes (CO):

CO1: Understand the concept, necessity and value of the Constitution as a Bill of Rights, and as a federal compact.

CO2: Appreciate the constitutional character of India as a welfare state.

CO3: Understand and analyze the relationship between the state and the people, especially in terms of the limits on the former in relation to the latter, and the obligations of the former towards the latter.

CO4: Appreciate the fundamental duties of citizens as participant actors of the welfare state.

CO5: Understand and analyze the federal structure of the constitutional polity and the scheme of distribution of powers between the Union and the States.

COURSE CONTENT

Module No.	Module Name	Chapter Topic	Description	CO
I	Introduction to Indian Constitution	- The idea of a constitution - The Preamble and key objectives of the Constitution of India - Salient features of the Constitution of India	Background and salient features	CO1
II	Republic of India as a welfare state	- Social justice principles - Gandhian principles - Separation of powers and independence of the judiciary - Promotion of international peace and security - Fundamental Duties	Directive Principles of State Policy and Fundamental Duties	CO1, CO2, CO3, CO4

III	The Constitution as a Bill of Rights	- Right to equality - Right to freedom - Right to freedom of religion and conscience - Cultural and educational rights - Economic rights in incorporation of directive principles	Fundamental Rights	CO1, CO2, CO3
IV	Republic of India as a Union of States	- India as a Union of States under Article 1 - Legislative relations: Seventh Schedule and the principle of repugnancy - President and Council of Ministers; Governor and Council of Ministers; - Extent of executive powers of the Union and the States	The Federal System	CO1, CO5

Suggested Readings:

1. Indian Constitutional Law (M.P. Jain, Ruma Pal)
2. Constitution of India (V.N. Shukla, M.P. Singh)
3. Constitutional Law of India (J.N. Pandey)
4. The Constitution of India (P.M. Bakshi)
5. The Oxford Handbook of the Indian Constitution (Madhav Khosla, Pratap Bhanu Mehta, Sujit Choudhry)

Teaching Pedagogy:

S. No.	Description	Used (Yes/No)
1	Lecture	Yes
2	Discussion/Demonstration	Yes
3	Case Study	No
4	Test/Assignment	Yes
5	Student Seminars/Presentation	Yes

CO-PO mapping:

CO/PO	P01 (Critical Thinking)	P02 (Effective Communication)	P03 (Social Interaction)	P04 (Effective Citizenship)	P05 (Ethics)	P06 (Environment and Sustainability)	P07 (Self-directed and Life-long Learning)
CO1	L			H	M	M	
CO2	L			H	M	M	
CO3	L			H	M	M	
CO4				H	M	M	
CO5	L			M			
Avg	0.8	0	0	2.8	1.6	1.6	0

*** **H** means High relevance, **M** means medium relevance, **L** means Low relevance

SEMESTER-III

Course Name: Mathematical Analysis-I

Course Type: Discipline Specific Core.

Credit: 4 [Lecture: 4, Practical: 0]

Course Outcomes (CO):

CO1: Understand real numbers and analyze the convergence of sequences and series used in statistical theory.

CO2: Apply limits, continuity, and differentiability to study the behavior of statistical functions.

CO3: Evaluate definite and improper integrals and use Beta and Gamma functions in probability and distribution theory.

CO4: Use partial and total derivatives to solve optimization problems in statistics.

CO5: Apply vector differentiation, double integrals, and Lagrange multipliers in multivariate data analysis.

COURSE CONTENT:

Module No.	Module Name	Chapter Topic	CO
I	Real number system, Sequences and Series of real numbers	Real number system: Representation of real numbers as points on a line. Algebraic, Order and Completeness properties of $\mathbb{R}$ (Concepts only), ϵ -neighborhood of a point in $\mathbb{R}$. Idea of countable sets, uncountable sets and uncountability of $\mathbb{R}$. Sequences of real numbers: Sequences and their convergence, limit of a sequence. Bounded and monotone sequences. Cauchy sequences. Properties and applications. Series of real numbers: Infinite series, positive termed series and their convergence, Comparison test, ratio test and root test. Absolute convergence of series, Conditional convergence.	CO1
II	Limit, Continuity and differentiability of real valued functions	Review of limits, continuity and differentiability. Indeterminate form, L' Hospital's rule. Rolle's Theorem. Mean value theorem for derivatives. Taylor's Series expansion. Maxima and Minima of Functions. Successive Differentiation.	CO2
III	Integral Calculus	Integral Calculus: Definite integral (definition). Statements of properties, Fundamental Theorem of Integral Calculus. Improper Integral, Beta and	CO2, CO3

		Gamma functions: properties and relationship between them.	
IV	Analysis of functions of two variables	Partial and total differentiation. Vector differentiation. Maxima and Minima of such Functions. Constrained Maximization and minimization, use of Lagrange Multiplier. Double integrals.	CO4, CO5

Reference Texts:

1. R.G. Bartle and D. R. Sherbert, Introduction to Real Analysis, 3rd Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2002.
2. Robert C. Wrede and Murray R. Spiegel, *Advanced Calculus*, 2nd Ed., Schaum's Outline Series, McGraw-Hill, 2002.
3. T.M. Apostol, Mathematical Analysis, Second Edition, Narosa Publishing House, New Delhi.
4. Walter Rudin, Principles of Mathematical Analysis, 3rd Ed., McGraw-Hill Education (Indian Edition)
5. S.K. Berberian, A First Course in Real Analysis, Springer Verlag, New York, 1994.
6. Malik S.C. and Savita Arora (1994): Mathematical Analysis, Second Edition, Wiley Eastern Limited, New Age International Limited, New Delhi.
7. Shanti Narayan (1987): A course of Mathematical Analysis, 12th revised Edition, S. Chand & Co. (Pvt.) Ltd., New Delhi.
8. S. Narayan and P.K. Mittal, *Integral Calculus*, S. Chand & Company Ltd., New Delhi, 2005.
9. M. Spivak, Calculus on Manifolds: A Modern Approach to Classical Theorems of Advanced Calculus, Westview Press, 1965.
10. S. K. Mapa, Introduction to Real Analysis, 9th Ed., Levant Books/Sarat Book Distributors (India), New Delhi, 2025.

Teaching Pedagogy:

S. No.	Description	Used (Yes/No)
1	Lecture	Yes
2	Discussion/Demonstration	Yes
3	Case Study	No
4	Test/Assignment	Yes
5	Student Seminars/Presentation	Yes

CO-PO mapping:

CO/PO	PO1 (Critical Thinking)	PO2 (Effective Communication)	PO3 (Social Interaction)	PO4 (Effective Citizenship)	PO5 (Ethics)	PO6 (Environment and Sustainability)	PO7 (Self-directed and Life-long Learning)
CO1	H	L	H	M	--	--	H
CO2	H	L	M	--	--	--	M
CO3	H	L	M	--	--	--	M
CO4	H	L	M	H	--	--	M
CO5	H	H	H	H	--	--	H
Average	3.0	1.4	2.4	1.6	0	0	2.4

*****H** means High relevance (3), **M** means medium relevance (2), **L** means Low relevance(1)

SEMESTER-III

Course Name: Sampling Distribution and Statistical Inference-I.

Course Type: Discipline Specific Core.

Credit: 4 [Lecture: 3, Practical: 1].

Course Outcomes (CO):

CO1: Understand and derive sampling distributions of statistics from univariate and bivariate distributions.

CO2: Use transformation techniques to derive the distributions of functions of random variables.

CO3: Analyze properties and applications of central and non-central distributions commonly arising in statistical inference.

CO4: Apply order statistics in sampling contexts and understand their distributions.

CO5: Comprehend the foundations of statistical inference, including estimation and hypothesis testing, and apply related techniques in parametric settings.

COURSE CONTENT

Module No.	Module Name	Chapter Topic	CO
I	Basics of Sampling Distribution	Concepts of population and sample, parameter and statistic Notion of sampling distribution of a statistic and its standard error Functions of random variables and their distributions using: ● Distribution function method ● Moment generating function method ● Transformation method with Jacobians Additive property of independent random variables • Orthogonal and polar transformations	CO1, CO3
II	Sampling distributions under univariate and bivariate normal populations	Central χ^2, t, and F distributions – derivation and key properties Idea of non-central distributions: Definitions and simple properties of non-central χ^2, t, and F Sampling distributions of sample mean and variance under univariate normal distribution Sampling distributions of sample means, variances and covariance in bivariate normal distribution Distribution of sample correlation coefficient (Population correlation coefficient=0 case) Distribution of regression coefficients	CO2, CO3
III	Order statistics	● Definition and distribution of sample order statistics (marginal and joint) ● Distribution of sample range	CO1, CO3, CO4

IV	Introduction to estimation and hypothesis testing	Types of inference: Estimation and hypothesis testing Concepts of point estimation: Estimator, mean squared error, unbiasedness, method of moments Interval estimation: Concepts and examples Hypothesis testing: ● Simple vs. composite hypotheses ● Null and alternative hypotheses ● Critical region, Type I and II errors, Level of significance, size, power, and p-value, Application: ● Parametric tests for mean and variance in univariate normal distribution	C05
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Suggested Readings:

Text Books:

1. Goon, A.M., Gupta, M.K., & Dasgupta, B. (2003). *An Outline of Statistical Theory*, Vol. 1, 4th Edn., World Press, Kolkata.
2. Rohatgi, V.K. and Saleh, A.K. Md. E. (2015). *An Introduction to Probability and Statistics (3rd Edition)*, Wiley Series in Probability and Statistics, India.

Reference Books:

3. Casella, G. & Berger, R.L. (2021). *Statistical Inference*, Cengage Learning.
4. Hogg, R.V. & Tanis, E.A. (2009). *A Brief Course in Mathematical Statistics*, Pearson Education.
5. Johnson, R.A. & Bhattacharya, G.K. (2001). *Introduction to the Theory of Statistics*, 3rd edition, Tata McGraw-Hill.
6. Mood, A.M., Graybill, F.A., & Boes, D.C. (1974). *Introduction to the Theory of Statistics*, McGraw-Hill.
7. Freund, J.E. (2021). *Mathematical Statistics with Applications*, 8th edition, Pearson.

Teaching Pedagogy:

S. No.	Description	Used (Yes/No)
1	Lecture	Yes
2	Discussion/Demonstration	Yes
3	Case Study	Yes
4	Test/Assignment	Yes
5	Student Seminars/Presentation	Yes

CO-PO mapping:

CO/PO	P01 (Critical Thinking)	P02 (Effective Communication)	P03 (Social Interaction)	P04 (Effective Citizenship)	P05 (Ethics)	P06 (Environment and Sustainability)	P07 (Self-directed and Life-long Learning)
CO1	H	M	H				H
CO2	H	L					H
CO3	H	L					H
CO4	H	M	M		L		H

C05	H	M	M	M	M		H
Average	3.0	1.6	1.4	0.4	0.6	0.0	3.0

*** **H** means High relevance, **M** means medium relevance, **L** means Low relevance

SEMESTER-III

Course Name: **Database Management System**

Credit: 4, [Lecture: 2, Practical: 2]

Course Outcomes (CO):

CO1: Understand the basic concepts and appreciate the applications of database systems.

CO2: Comprehend the fundamentals of design principles for the logical design of relational databases.

CO3: Apply query writing skills and optimize queries effectively.

CO4: Understand the basic issues of transaction processing and concurrency control.

CO5: Analyze and evaluate database storage structures and indexing techniques for efficient data retrieval.

COURSE CONTENT:

Module No.	Module Name	Chapter Topic	CO
I	Introduction	Concept & Overview of DBMS, Applications, Data Models, Database Languages, Database Administrator, Database Users, Three Schema architecture of DBMS, Basic concepts, Design Issues, Mapping Constraints,	CO1

		Keys, Entity-Relationship Diagram, Weak Entity Sets, Extended E-R features Structure of relational Databases, Relational Algebra, Relational Calculus, Extended Relational Algebra Operations, Views, Modifications of the Database	
II	SQL and Integrity Constraints & Index Structures,	Concept of DDL, DML, DCL. Basic Structure, Set operations, Aggregate Functions, Null Values, Domain Constraints, Referential Integrity Constraints, assertions, views, Nested Sub queries, Database security application development using SQL, Stored procedures and triggers. Necessity of index structures, Types of Single-Level Index (primary, secondary, clustering), Multi level Indexes, Dynamic Multi level Indexes using B tree and B+ tree	CO2
III	Normalization & Transaction processing	Functional Dependency, Anomalies in a Database, The normalization process: Conversion to first normal form, Conversion to second normal form, Conversion to third normal form and BCNF, Fourth Normal form and fifth normal form, normalization and database design, De-normalization, Loss-less join decomposition, Dependency preservation Introduction of transaction processing, advantages and disadvantages of transaction processing system, online transaction processing system, serializability and recoverability, view serializability	CO3
IV	Concurrency Control & Database recovery management	Serializability: Enforcing, Serialize ability by Locks, Locking Systems With Several, Lock Modes, Architecture for a Locking Scheduler Managing Hierarchies of Database Elements, Concurrency Control by Timestamps, Concurrency Control by Validation Deferred database modification Vs. Immediate Database modification, Checkpoint technique	CO4
V	Query Optimization & Distributed Database (DDB)	Heuristics in Query Optimization, Converting Query Tree to Query Evaluation Plan Introduction of DDB, DDBMS architectures, Homogeneous and Heterogeneous databases, Distributed data storage, Advantages of Data Distribution, Disadvantages of Data Distribution Distributed transactions, Commit protocols, Data Replication, Data Fragmentation. Distributed database transparency features	CO5

Suggested Readings:

Text Books:

1. An Introduction to Database Systems”, C.J Date, Pearson Education.
2. Database System Concepts”, Abraham Silberschatz, Henry F. Korth and S. Sudarshan, McGraw-Hill.
3. Distributed Databases Principles & Systems”, Stefano Ceri and Giuseppe Pelagatti, McGraw-Hill International Editions.

Reference Books:

1. Fundamentals of Database Systems”, Ramez Elmasri and Shamkant B. Navathe, Addison-Wesley.

Teaching Pedagogy:

S. No.	Description	Used (Yes/No)
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1	Lecture	Yes
2	Discussion/Demonstration	Yes
3	Case Study	No
4	Test/Assignment	Yes
5	Student Seminars/Presentation	Yes

CO-PO mapping:

CO/PO	PO1 (Critical Thinking)	PO2 (Effective Communication)	PO3 (Social Interaction)	PO4 (Effective Citizenship)	PO5 (Ethics)	PO6 (Environment and Sustainability)	PO7 (Self-directed and Life-long Learning)
CO1	M	H	M	H	H		
CO2	M	H		M		H	M
CO3	M	H	M	M	M		M
CO4	H	M	M				M
CO5	M	M	M	M		M	M
Average	2.2	2.6	1.6	1.8	1	1	1.6

SEMESTER-III

Course Name: Financial Technology

Course Type: Multi-Disciplinary Course.

Credit: 3 [Lecture: 3, Practical: 0].

Course Outcomes (COs) (Tentative):

CO#	COGNITIVE ABILITIES	COURSE OUTCOMES
CO1	REMEMBERING	To relate the concept of financial technology
CO2	UNDERSTANDING	To describe financial technology based on different business models and strategies.

CO3	APPLYING	To practice, classify and compare between different modes of electronics payment mechanisms.
CO4	ANALYSING	To analyze functions, scopes and risks involved in fintech Industry.
CO5	EVALUATING AND CREATING	Assess and evaluate emerging technologies related to fintech

COURSE CONTENT

Module Number	Module Name	Topics	CO
I	Introduction	1.1 Meaning and scope of finance, financial technology, Evolution of financial services, Major FinTech domains, Drivers of digital transformation, FinTech ecosystem and players. 1.2 Top fintech trends (only basic concept): Embedded finance, open banking, Digital only banking, chatbots and virtual assistants (robotic process automation), Big data analytics	CO1, CO 2
II	Digital Transactions	2.1 <u>E-Payment System</u> : Payment systems overview, Methods of e-payment (Debit Card, Credit Card, Smart Cards, e-money), Mobile payments & e-wallets, Real-time payments, QR-based payments, payment gateways. Online banking (concept, importance, electronic fund transfer – RTGS, NEFT). Basic concept of CBS. Risks involved in e-payments (Tax evasion, Fraud, Impulse buying, Payment conflict). Introduction of Mobile Commerce, – Global Mobile E-Commerce – Secure Mobile Commerce, Challenges of E-commerce 2.2 SEO-Basics, onsite and offsite optimization techniques, Alternative Lending & Crowdfunding.	CO3
III	Security and Technology Solution	3.1 Dimensions of security, Security threats in the fintech environment – malicious codes (virus, Trojan, worm), hacking, spoofing, sniffing, phishing, cyber-vandalism. Encryption, Decryption, Symmetric & Asymmetric Encryption, Secured Electronic Transaction (https, SSL), protecting networks (Firewall, DMZ)). RegTech tools & automation, Fraud detection using AI.	CO4
IV	Recent Development in Fintech	4.1 Basics of AI and ML technology, AI-driven finance & GenAI in banking, How AI is Transforming the Future of FinTech – AI & Governance – New Challenges of AI and Machine Learning – Challenges of Data Regulation, Algorithmic investment management, Robo-advisors. 4.2 Blockchain Technology, Distributed Ledger Technology (DLT), Basics of Cryptocurrency & Tokenization	CO3, CO4

Suggested Reading: (Theory)

1. Amalia, Fitri., THE FINTECH BOOK: THE FINANCIAL TECHNOLOGY HANDBOOK FOR INVESTORS, ENTREPRENEURS AND VISIONARIES.. 31. 345. 10.22146/jieb.23554
2. Chisti, S., and Barberis, J. The FINTECH Book: The Financial Technology Handbook for

Investors, Entrepreneurs and Visionaries. John Wiley & Sons Ltd: West Sussex.
3. Chris Skinner, Digital Human, Wiley

Teaching Pedagogy:

S. No.	Description	Used (Yes/No)
1	Lecture	Yes
2	Discussion/Demonstration	Yes
3	Case Study	Yes
4	Test/Assignment	Yes
5	Student Seminars/Presentation	Yes

CO-PO mapping:

CO/PO	PO1 (Critical Thinking)	PO2 (Effective Communication)	PO3 (Social Interaction)	PO4 (Effective Citizenship)	PO5 (Ethics)	PO6 (Environment and Sustainability)	PO7 (Self-directed and Life-long Learning)
C01	H	M	H				H
C02	H	L	H				
C03	H	L					H
C04	H	M	M		L		H
C05	H	M	M	M	M		H
Avg	3.0	1.6	2	0.4	0.6	0.0	2.4

*** **H** means High relevance, **M** means medium relevance, **L** means Low relevance

SEMESTER-III**Course Name: Basics of Accounting****Course Type:** Multi-Disciplinary Course.**Credit:** 3 [Lecture: 4, Practical: 0]**Course Outcomes (COs) (Tentative):**

CO#	COGNITIVE ABILITIES	COURSE OUTCOMES
CO1	REMEMBERING	Familiarizing students with the mechanics of fundamentals of accounting
CO2	UNDERSTANDING	Acquainting the accounting system and prepare necessary books of accounts.
CO3	APPLYING	Applying the accounting principles, rules and procedures in recording different types of transactions.
CO4	ANALYSING	Analyzing and interpreting the financial statements using accounting ratios.
CO5	EVALUATING AND CREATING	Creating financial statements and evaluating financial positions will enable students to take informed decisions

COURSE CONTENT

Module Number	Module Name	Topics	CO
I	Introduction to Financial Accounting	1.3 Introduction to Financial Accounting, Accounting Principles, Understanding Assets, Liabilities, Revenues, and Expenses, Bases of Accounting 1.4 Accounting cycle, Accounting Equation, Transaction analysis 1.5 Nature of Accounts and Rules of Debit and Credit. 1.6 Recording transactions in General Journal. Preparation of Ledger Accounts. Preparation of Trial Balance.	CO1, CO 2
II	Financial Statement Preparation and Presentation	2.1 Financial Statements: Objective, Importance and Limitations; Capital Expenditure, Revenue Expenditure, Deferred Revenue Expenditure, Capital Receipts, and Revenue Receipts. 2.2 Preparing Trading Account, Profit & Loss Account and Balance Sheet for a Sole Proprietor with simple adjustments (Trading Concern). 2.3 Corporate Financial Reporting, Understanding the contents of a Corporate Annual Report (Actual latest annual reports to be used).	CO3, CO4
III	Financial Statement Analysis	3.1 Objectives of Financial Statement Analysis; Sources of information; Standards of Comparison. 3.2 Techniques of Financial Statement Analysis (Through a case study of real company) - Ratio analysis (computation and interpretation), Cash flow analysis (structure, presentation and interpretation), Trend analysis, Common size statement analysis, Comparative statement analysis, Use of ratios to predict financial crisis of a company by using Altman Z –score, introduction to Earnings Management	CO 4, CO5

Suggested Reading: (Theory)

- Robert N. Anthony, David Hawkins, Kenneth A. Merchant, Accounting: Text and Cases, McGraw-Hill
- Gupta, R. L. and Radhaswamy, M: Financial Accounting; S. Chand & Sons
- Maheshwari: Introduction to Accounting; Vikas Publishing
- P.C. Tulsian, Financial Accounting, Pearson Education.
- V.K. Goyal & Ruchi Goyal, Financial Accounting, PHI Learning.
- Hanif and Mukherjee - Financial Accounting –McGraw –Hill Education India Pvt.Ltd

Teaching Pedagogy:

S. No.	Description	Used (Yes/No)
1	Lecture	Yes
2	Discussion/Demonstration	Yes
3	Case Study	Yes
4	Test/Assignment	Yes
5	Student Seminars/Presentation	Yes

CO-PO mapping:

CO/PO	PO1 (Critical Thinking)	PO2 (Effective Communication)	PO3 (Social Interaction)	PO4 (Effective Citizenship)	PO5 (Ethics)	PO6 (Environment and Sustainability)	PO7 (Self-directed and Life-long Learning)
CO1	H	M	H				H
CO2	H						H
CO3	H						
CO4	H	M	M		L		H
CO5	H	M	M	M	M		H
Avg	3.0	1.2	1.2	0.4	0.6	0.0	2.4

*** **H** means High relevance, **M** means medium relevance, **L** means Low relevance

SEMESTER-III

Course Name: Modern Indian Language (MIL I) – Hindi I

Course Type: Ability Enhancement Course.

Credit: 2 [Lecture: 2, Practical: 0].

COURSE CONTENT

UNIT-1 साहित्य (LITERATURE) (Marks allotted : 20)

कथा साहित्य

- (1) त्रिशंकु (मन्नू भंडारी)
 - (2) सिक्का बदल गया (कृष्णा सोबती)
 - (3) ब्लैक होल (संजीव)
- { तर्कसम्मत एवं समीक्षात्मक प्रश्न पूछे जाएंगे। }

UNIT-2 भाषा (LANGUAGE) (Marks allotted : 20)

अनुवाद विज्ञान

- (1) अनुवाद की परिभाषा, भेद, महत्व एवं प्रासंगिकता।
 - (2) हिंदी अनुवाद का भविष्य।
 - (3) व्यावहारिक अनुवाद में आने वाली समस्याएँ।
 - (4) अंग्रेजी से हिंदी का व्यावहारिक अनुवाद।
- { तर्कसम्मत एवं समीक्षात्मक प्रश्न पूछे जाएंगे। }

UNIT-3 दक्षता (SKILL) (Marks allotted : 10)

वर्तनी

- (1) वर्तनी की अशुद्धियों का संक्षिप्त ज्ञान।
(वर्तनी क्या है, हिंदी में कितने प्रकार की वर्तनी की अशुद्धियाँ होती हैं एवं उन्हें कैसे सुधारा जा सकता है।)
 - (2) प्रूफ संशोधन।
- { वस्तुनिष्ठ प्रश्न पूछे जाएंगे। }

SEMESTER-III

Course Name: Modern Indian Language I- Bengali I

Course Type: Ability Enhancement Course.

Credit: 2 [Lecture: 2, Practical: 0].

Paper Structure – Continuous Internal Assessment (30%) + End Semester Examination (70%)

Continuous Internal Assessment – Project/assignment/test, Mid-semester Examination, attendance

End Semester – Written exam

Credit Division – Unit 1: One credit, Unit II & III: One credit, Total: 2 credits

Unit – I, Literature সাহিত্যপাঠ (20 Marks: Q1, A রবীন্দ্র কবিতা / B রবীন্দ্র ছোটগল্প)

A) রবীন্দ্রকবিতা পাঠ: নৈবেদ্য কাব্য

১। তোমার পতাকা যারে দাও

- ২। শতাব্দীর সূর্য আজি
৩। চিত্ত যেথা ভয়শূন্য, উচ্চ যেথা শির
- B) রবীন্দ্র ছোটগল্প পাঠ:
১। পোস্টমাস্টার
২। মণিহারী

Unit – II, Language ভাষাপাঠ (20 Marks: Q2, A বোধপরীক্ষণ / B প্রতিবেদন লিখন / C সংলাপ লিখন)

Comprehension

A) বোধপরীক্ষণ – নির্বাচিত কোনো বাংলা সাহিত্য প্রবন্ধ থেকে নির্বাচিত অংশ বোধ-পরীক্ষণের জন্য উদ্ধৃত করে প্রশ্ন করা হবে।

Writing Skill

B) প্রতিবেদন রচনা: সংবাদপত্রে প্রকাশের উপযোগী সাম্প্রতিক কোনও ঘটনার প্রতিবেদনের খসড়া রচনা করতে হবে।

অথবা

C) সংলাপ লিখন: গল্পাংশ অথবা উপন্যাসের অংশ থেকে সংলাপ ভিত্তিক পুনর্নির্মাণ করতে হবে।

Unit – III, Skill দক্ষতা (10 marks: Q3, A পরিভাষা / B বাংলা বানান)

A) পরিভাষা – বাংলা পরিভাষার নির্বাচিত তালিকা থেকে ৫টি লিখতে হবে, প্রশ্নে চিহ্ন দেওয়া থাকবে।

B) বানানবিধি – পশ্চিমবঙ্গ বাংলা আকাদেমি প্রণীত 'আকাদেমি বানান অভিধান' অনুসারে বাংলা বানান বিষয়ক সিদ্ধান্তগুলি ক্লাসে আলোচিত হবে, এন্ড সেম পরীক্ষায় চিহ্নিত অশুদ্ধ বানান দেওয়া হবে, ৫টি শুদ্ধ করে লিখবে।

SEMESTER-III

Course Name: Business Communication I

Course Type: Ability Enhancement Course.

Credit: 2 [Lecture: 2, Practical: 0].

Course Outcomes (CO):

- CO1. Develop proficiency in speaking, reading, writing, and listening in both English and one Indian language.
- CO2. Facilitate constructive dialogue and mediate disagreements to reach consensus in group settings.
- CO3. Develop an understanding of grammatical conventions and principles in English writing.
- CO4. To create effective communicators with the ability to express themselves in the workplace and elsewhere
- CO5. Demonstrate the ability to integrate language and communication skills to produce clear, coherent, and context-appropriate presentations and documents.

COURSE CONTENT

Sno	Module Name	Description	CO
I	Vocabulary and English for	Students are expected to read newspapers, business news, magazines to build vocabulary for business	CO1, CO4

	Business Communication	communication. The reading material is provided by the faculty as and when required.	
II	Communicative English	Students participate in group activities to understand the purpose and responses in interpersonal communication from personal to professional situations. Stanford University's Business School after a lot of research work has come up with these role-playing activities to help learners become good speakers and overcome their anxiety of communicating in public. Following their research work, students are made to do certain exercises in the class helping them overcome their stage-fear. To understand the dynamics of group communication, students are made to participate in various team activities followed by their experience sharing and learning. Students make Group Presentations which are part of their internal evaluation.	CO2, CO3
III	Theories of Communication	Importance of Communication, Communication Process, Channels of communication, Significance of Feedback, Barriers to Effective Communication, Ways to overcome the Barriers.	CO4, CO5
IV	Formal Letter and E-Mail Writing	Students learn how to write formal letters; more than the format, in this unit the focus is on the style of language used in a formal letter which has an authority of the message to be conveyed yet not offensive. Students are taught how to generally introduce a formal letter and conclude it following a narrative which avoids any kind of exaggeration and jargon. Following the same style of language and narration they are taught about the usage of e-mail in today's world. The importance of it and the way they should use it, eg. the usage of 'CC', 'BCC', how to attach files and what to write before they attach any document.	CO1, CO3, CO4

Teaching Pedagogy:

S. No.	Description	Used (Yes/No)
1	Lecture	Yes
2	Discussion/Demonstration	Yes
3	Case Study	Yes

4	Test/Assignment	Yes
5	Student Seminars/Presentation	Yes

CO-PO mapping:

CO/PO	PO1 (Critical Thinking)	PO2 (Effective Communication)	PO3 (Social Interaction)	PO4 (Effective Citizenship)	PO5 (Ethics)	PO6 (Environment and Sustainability)	PO7 (Self-directed and Life-long Learning)
CO1	H	M	H				H
CO2	H						H
CO3	H						
CO4	H	M	M		L		
CO5	H	M	M	M	M		H
Avg	3.0	1.2	1.2	0.4	0.6	0.0	1.8

*** **H** means High relevance, **M** means medium relevance, **L** means Low relevance

SEMESTER-III

Course Name: Python

Course Type: Skill Enhancement.

Credit: 3 [Lecture: 0, Practical: 3].

Course Outcomes (CO):

CO1: Set up and navigate Python environments (Anaconda, Jupyter, Spyder), and understand fundamental syntax and operations.

CO2: Use Python's built-in data structures and libraries for data manipulation and basic programming

tasks.

CO3: Perform descriptive statistical analysis and create visualizations using libraries like Matplotlib and Seaborn.

CO4: Apply inferential statistical techniques in Python, including hypothesis testing, correlation, ANOVA, and regression.

CO5: Develop and analyze statistical models using Python and present results in a meaningful way.

COURSE CONTENT

Module No.	Module Name	Chapter Topic	CO
I	Python Fundamentals and Data Handling	● Introduction to Python & Environments: Installing Anaconda (Individual Edition), using Python Shell, introduction to Spyder and Jupyter Notebook. ● Python Basics: Numbers, variables, comparisons, logic, strings, lists, tuples—with examples. ● Control Structures: Loops (for, while), conditional statements (if, elif, else), file input/output. ● Functions: Defining functions, lambda functions, using map() and filter(), working with lists, tuples, and dictionaries. ● Simple Plotting: Introduction to Matplotlib—basic plots, labels, legends, customization. ● Advanced Data Structures: Sets and dictionaries, error and exception handling, useful idioms in Python. ● Introduction to Libraries: NumPy (arrays, functions, matrix operations), reading/writing arrays, descriptive stats with NumPy, polynomial fitting, root-finding, sampling (Uniform, Normal, Binomial, Poisson, with/without replacement), permutations.	CO1, CO2

II	Descriptive Statistics and Data Visualization	Descriptive Statistics: Frequency, mean, median, mode, range, quartiles, max, min, percentiles, correlation. Data Exploration: Summarizing univariate/multivariate data, handling missing values, basic EDA with Pandas. Data Visualization Techniques: ● Univariate: Histogram, bar plot, pie chart, box plot, stem-leaf plot. ● Multivariate: Scatter plot, heatmap, line plot. Using Matplotlib & Seaborn for visual summaries and plot customization.	C05
III	Basic Inferential Statistics and Statistical Modeling in Python	● Inferential Statistics: Confidence intervals, hypothesis testing (Z-test, t-test, chi-square), left/right/two-tailed tests, one-sample, two-sample, and paired-sample tests. ● Regression & ANOVA: Simple/multiple linear regression, ANOVA (one-way), residual analysis, model diagnostics. ● Introduction to SciPy & Statsmodels for statistical analysis. ● Pandas: DataFrames, reading/writing text, CSV, Excel; web scraping; data cleaning and grouping; statistical functions.	C04, C05

IV	Case Study and Group Project	● Hands-on Case Study: Real-world dataset analysis using learned tools. ● Model Fitting and Evaluation: Linear and logistic regression with interpretation, visualization, and reporting. ● Plotting and Communication: Custom visualizations using Matplotlib and Seaborn; presenting results using Pandas DataFrames. ● Project Work: Group-based project involving EDA, modeling, interpretation, and presentation.	C05
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Suggested Readings:

Text Books:

1. *Learning Scientific Programming with Python* – Christian Hill, Cambridge University Press (2020).
2. *Foundations of Statistics for Data Scientists with R & Python* – Alan Agresti, Maria Kateri; CRC Press (2022).

Reference Manuals:

3. Anaconda Distribution Documentation – <https://www.anaconda.com/products/distribution>
4. Spyder IDE Documentation – <https://docs.spyder-ide.org/current/index.html>
5. Interactive statistics platform – <http://stat4ds.rwth-aachen.de>

Teaching Pedagogy:

S. No.	Description	Used (Yes/No)
1	Lecture	Yes
2	Discussion/Demonstration	Yes

3	Case Study	Yes
4	Test/Assignment	Yes
5	Student Seminars/Presentation	Yes

CO-PO mapping:

CO/PO	PO1 (Critical Thinking)	PO2 (Effective Communication)	PO3 (Social Interaction)	PO4 (Effective Citizenship)	PO5 (Ethics)	PO6 (Environment and Sustainability)	PO7 (Self-directed and Life-long Learning)
CO1	H	L					H
CO2	H	L					H
CO3	H	M					H
CO4	H	M	L		L		H
CO5	H	H	M	L	M	L	H
Avg	3.0	1.8	0.6	0.2	0.6	0.2	3.0

*** **H** means High relevance, **M** means medium relevance, **L** means Low relevance

SEMESTER-IV

Course Name: Statistical Inference-II.

Course Type: Discipline Specific Core.

Credit: 4 [Lecture: 3, Practical: 1].

Course Outcomes (CO):

CO1: Explain and apply core concepts of point estimation including unbiasedness, consistency, efficiency, and sufficiency.

CO2: Use classical estimation techniques such as the Method of Moments and Maximum Likelihood Estimation and evaluate their statistical properties.

CO3: Understand and implement fundamental principles of hypothesis testing including the Neyman-Pearson Lemma, MP, UMP, and UMPU tests.

CO4: Apply the theory and methods of Likelihood Ratio Tests to simple and composite hypotheses.

CO5: Construct and interpret confidence intervals and uniformly most accurate (UMA) confidence sets and understand their relationship to hypothesis tests.

COURSE CONTENT

Module No.	Module Name	Chapter Topic	CO
I	Theory of estimation	● Concepts: Estimator, Estimation, Bias, Mean Squared Error, Unbiasedness ● Sufficiency and Factorization Theorem (Proof in discrete case), Minimal Sufficiency ● Uniformly Minimum Variance Unbiased Estimators (UMVUE): conditions and properties ● Fisher's Information ● Cramér-Rao inequality and Minimum Variance Bound (MVB) ● Completeness; Ancillary Statistic, Basu's Theorem – statement and application ● Rao-Blackwell Theorem and applications; Lehmann Scheffe Theorem	CO1

II	Methods of estimation	● Method of Moments – formulation, examples, properties ● Maximum Likelihood Estimation (MLE): likelihood function, examples ● Minimum Chi-square method	CO2
III	Hypothesis Testing	● Review: Simple vs. composite hypotheses, null/alternative, errors, power ● Notion of p-value and its application ● Test functions: Randomized and non-randomized tests ● Neyman-Pearson Lemma: statement and proof (sufficiency part); applications to MP and UMP tests ● UMPU tests (definition only) ● Likelihood Ratio Tests (LRT): concept, examples ● Tests on bivariate normal distribution – mean, correlation, regression coefficients	CO3, CO4
IV	Confidence Intervals and UMA Confidence Sets	● Concepts: Interval estimation and confidence level ● Uniformly Most Accurate (UMA) confidence sets: concept and examples ● Relationship between hypothesis tests and confidence intervals ● Confidence intervals for means, variances, proportions (Under univariate/bivariate normal distribution)	CO5

Suggested Readings:

Text Books:

1. Goon, A.M., Gupta, M.K., Dasgupta, B. (2005). Outline of Statistics, Vol. I & II, World Press.
2. Rohatgi, V.K., Saleh, A.K. Md. E. (2009). An Introduction to Probability and Statistics, Wiley.

Reference Books:

3. Casella, G., Berger, R.L. (2002). Statistical Inference, 2nd Ed., Duxbury.
4. Miller, I. and Miller, M. (2002). John E. Freund's Mathematical Statistics, Prentice Hall.
5. Dudewicz, E.J., Mishra, S.N. (1988). Modern Mathematical Statistics, Wiley.
6. Mood, A.M., Graybill, F.A., Boes, D.C. (1974). Introduction to the Theory of Statistics, McGraw-Hill.

List of Practicals

1. Estimation using Maximum Likelihood Estimation (MLE)
2. Estimation by Method of Moments and Minimum Chi-square
3. Simulation and interpretation of Type I and Type II errors
4. Construction of Most Powerful (MP) tests
5. Construction of Uniformly Most Powerful (UMP) tests
6. Plotting and interpreting power curves
7. Construction of confidence intervals
8. Likelihood Ratio Tests

Teaching Pedagogy:

S. No.	Description	Used (Yes/No)
1	Lecture	Yes
2	Discussion/Demonstration	Yes
3	Case Study	Yes

4	Test/Assignment	Yes
5	Student Seminars/Presentation	Yes

CO-PO mapping:

CO/PO	PO1 (Critical Thinking)	PO2 (Effective Communication)	PO3 (Social Interaction)	PO4 (Effective Citizenship)	PO5 (Ethics)	PO6 (Environment and Sustainability)	PO7 (Self-directed and Life-long Learning)
CO1	H	L					H
CO2	H	M					H
CO3	H	M			L		H
CO4	H	L			L		H
CO5	H	M					H
Avg	3.0	1.6	0.0	0.0	0.4	0.0	3.0

*** **H** means High relevance, **M** means medium relevance, **L** means Low relevance

Semester-IV

Course Name: Linear Algebra and Linear Statistical Models

Course Type: Discipline Specific Core.

Credit: 4 [Lecture: 3, Practical: 1].

Course Outcomes (CO):

CO1: Understand the concepts of vector spaces, subspaces, linear independence, basis, dimension; apply them to solve problems in statistical modeling.

CO2: Analyze and apply matrix operations, rank, inverse, and system of linear equations using methods like Gaussian elimination in the context of multivariate statistical data.

C03: Interpret eigenvalues, eigenvectors, and diagonalization, and use them in principal component analysis and other techniques in multivariate statistics.

C04: Understand and apply the principles of linear estimation within the Gauss-Markov framework.

C05: Employ regression models, ANOVA, and ANCOVA techniques for comprehensive data analysis in various contexts.

COURSE CONTENT:

Module No.	Module Name	Chapter Topic	CO
I	Vector Spaces, Linear Transformation and Matrices	Vector Space: Definition of vectors, operation of vectors (angle, distance etc.). Vector spaces, Subspaces, sum of subspaces, Span of a set, Linear dependence and independence, dimension and basis. Extension of basis. Orthogonal vectors, Gram-Schmidt Orthogonalization. Algebra of matrices. Linear Transformation: Definition, The matrix representations of a linear transformation, Rank, Nullity, Dimension Theorem. Elementary matrices and their uses, theorems related to triangular, symmetric and skew symmetric matrices, idempotent matrices, orthogonal matrices. Trace of a matrix. Determinants of Matrices: Definition, properties and applications of determinants. Use of determinants in solution to the system of linear equations. Adjoint and inverse of a matrix and related properties. Basic idea of Generalized Inverse of a matrix. Singular and non-singular matrices and their properties.	C01, C02, C03
II	System of linear equations, Eigen Value and Eigen vectors, Quadratic Forms	Systems of linear equations: row reduction and echelon forms, rank of a matrix, the matrix equation $Ax=b$, solution sets of linear systems, applications of linear systems.	C01, C02, C03

		Partitioning of matrices and simple properties. Eigen vectors and Eigen values: Characteristic roots and Characteristic vectors, Properties of characteristic roots. Cayley Hamilton Theorem. Quadratic forms: Classification & canonical reduction.	
III	Linear Estimation and Regression Modeling	Gauss-Markov set up; Gauss-Markov theorem. BLUE. Fundamental Theorems on least squares (statements only), Simple and Multiple Regression: Estimation and hypothesis testing in case of simple and multiple regression models.	C04
IV	Linear Models with ANOVA/ANCOVA Applications	Definitions of fixed, random and mixed effects models. Analysis of variance for one-way classified data for fixed and random effects models. Analysis of variance for two-way classified data (with equal number of observations per cell) for fixed/random/mixed effects models. Analysis of covariance (with one concomitant variable) in one-way and two-way classified data, for fixed effects models.	C05

Suggested Readings:

Text books:

- Hoffmann, K., & Kunze, R. A. (1971). *Linear algebra*. Hoboken, NJ: Prentice-Hall.
- Renchner, A. C. And Schaalje, G. B. (2008). *Linear Models in Statistics* (Second edition), John Wiley and Sons.
- Strang, G. (2022). *Introduction to linear algebra*. Wellesley-Cambridge Press.
- Scheffe, H. (1999). *The analysis of variance*. John Wiley & Sons.

Reference books:

- Seber, G. A., & Lee, A. J. (2003). *Linear regression analysis*. John Wiley & Sons.
- Rao, C. R., Rao, C. R., Statistiker, M., Rao, C. R., & Rao, C. R. (1973). *Linear statistical inference and its applications* (Vol. 2, pp. 263-270). New York: Wiley.

- Bapat, R. B. (2012). *Linear algebra and linear models*. Springer Science & Business Media.
- Mapa, S. K. (2003). *Higher Algebra: Abstract And Linear (revised Ninth Edition)*. Sarat Book Distributors.
- Searle, S. R. (1997). *Linear models*. John Wiley & Sons.

List of Suggested Practical:

- Estimability when X is a full rank matrix and not a full rank matrix
- Simple Linear Regression
- Multiple Regression
- Tests for Linear Hypothesis
- Bias in regression estimates
- Lack of fit
- Analysis of Variance of a one-way classified data
- Analysis of Variance of a two-way classified data with one observation per cell
- Analysis of Covariance of a one-way classified data
- Analysis of Covariance of a two-way classified data

Teaching Pedagogy:

S. No.	Description	Used (Yes/No)
1	Lecture	Yes
2	Discussion/Demonstration	Yes
3	Case Study	No
4	Test/Assignment	Yes
5	Student Seminars/Presentation	Yes

CO-PO mapping:

CO/PO	PO1 (Critical Thinking)	PO2 (Effective Communication)	PO3 (Social Interaction)	PO4 (Effective Citizenship)	PO5 (Ethics)	PO6 (Environment and Sustainability)	PO7 (Self-directed and Life-long Learning)
CO1	H	L	H				H
CO2	H	H	M				H
CO3	H	M	M				H
CO4	M	L	M				H
CO5	H	H	L				H
Average	2.8	2.0	2.0	0	0	0	3.0

CO-PO mapping:

*****H** means High relevance (3), **M** means medium relevance (2), **L** means Low relevance (1)

SEMESTER- IV

Course Name: Multivariate Analysis

Course Type: Discipline Specific Core

Credit: 4 [Lecture: 3, Practical: 1].

Course Outcomes (CO):

CO1: Understand the fundamental concepts of multivariate distributions, including random vectors, mean vectors, dispersion matrices, and conditional/marginal distributions.

CO2: Demonstrate knowledge of multivariate probability distributions such as the multivariate normal, multinomial, Wishart, and Hotelling's T^2 distributions and their properties.

CO3: Analyze the sampling distributions of statistics derived from multivariate normal distributions and interpret the relationships using multiple and partial correlation coefficients.

CO4: Apply dimension reduction techniques such as Principal Component Analysis (PCA) and Factor Analysis in multivariate data analysis.

CO5: Develop the ability to synthesize multivariate statistical knowledge to real-life problems and pursue further study or research independently in this field.

COURSE CONTENT

Module No.	Module Name	Chapter Topic	CO
I	Introduction to multivariate distributions	Multivariate Data: Random Vector: Probability mass/density functions, Distribution function, Mean vector & Dispersion matrix, Marginal & Conditional distributions.	CO1, CO5
II	Multivariate distributions	Multinomial distribution and its properties. Multivariate Normal distribution and its properties (including Fisher-Cochran theorem).	CO2, CO5
III	Sampling distributions of statistics in multivariate normal distribution	Sampling distributions of mean vector and variance- covariance matrix. Wishart distribution and its properties. Hotelling's T^2 distribution.	CO3, CO5
IV	Sampling distributions of multiple and partial correlation coefficients	Sampling distributions of multiple and partial correlation coefficients (without proof) and their properties	CO4, CO5

Suggested Readings:

Text Books:

1. Anderson, T.W. (2003): An Introduction to Multivariate Statistical Analysis, 3rd Edition., John Wiley & Sons, Inc.
2. Muirhead, R.J. (1982): Aspects of Multivariate Statistical Theory, John Wiley & Sons, Inc.
3. Kshirsagar, A.M. (1972): Multivariate Analysis, 1st Edition Marcel Dekker.
4. Johnson, R.A. and Wichern, D.W. (2007): Applied Multivariate Analysis, 6th Edition., Pearson.

Reference Books:

1. Kotz, Samuel, Balakrishnan, N. and Johnson, Norman L. (2000): Continuous Multivariate Distributions: Models and Applications. Vol. 1. 2nd Edition. John Wiley & Sons, Inc.
2. Johnson, Norman L., Kotz, Samuel and Balakrishnan, N. (1997): Discrete Multivariate Distributions. John Wiley & Sons, Inc.

List of Practicals:

1. Multiple Correlation
2. Partial Correlation
3. Multivariate Normal Distribution
4. Multinomial distribution
5. Hotelling's T^2

Teaching Pedagogy:

S. No.	Description	Used (Yes/No)
1	Lecture	Yes
2	Discussion/Demonstration	Yes
3	Case Study	No
4	Test/Assignment	Yes
5	Student Seminars/Presentation	No

CO-PO mapping:

CO/PO	P01 (Critical Thinking)	P02 (Effective Communication)	P03 (Social Interaction)	P04 (Effective Citizenship)	P05 (Ethics)	P06 (Environment and Sustainability)	P07 (Self-directed and Life-long Learning)
C01	H	M	H	H	–	–	–
C02	H	–	L	–	–	–	H
C03	H	–	L	–	–	–	H
C04	H	M	M	L	–	–	H
C05	H	M	M	M	M	–	H
Avg	3.0	1.6	1.2	0.4	0.6	0.0	3.0

*** **H** means High relevance, **M** means medium relevance, **L** means Low relevance

SEMESTER-IV

Course Name: Data Analysis with R.

Course Type: Minor.

Credit: 4 [Lecture: 0, Practical: 4].

Course Outcomes (CO):

C01: Understand the R environment, perform basic mathematical operations, and handle various data types in R.

C02: Create and manipulate data structures like vectors, matrices, data frames, and lists, and apply appropriate data summarization techniques.

C03: Apply graphical tools in R for effective data visualization using base R and ggplot2 packages.

C04: Perform statistical analyses including univariate and bivariate statistics, regression modeling, and probability computations in R.

C05: Write R scripts involving loops, conditionals, user-defined functions, and simulations to solve real-world statistical problems.

COURSE CONTENT

Module No.	Module Name	Chapter Topic	CO
I	Introduction to R and Fundamentals of Data Structures	● Overview of R: History and philosophy (open-source), CRAN, installing R and RStudio, R Console, R Script ● Basic Operations: Arithmetic, assignment, logical expressions, standard functions (log, exp, sqrt, abs, etc.) ● Command History & Help: history(), help(), ?function_name, quit() ● Basic Objects: Scalars, vectors (numeric, character, logical), factors ● Creating Vectors: c(), seq(), rep(), colon operator ● Indexing & Subsetting: Position, condition-based, negative indexing	CO1
II	Linear Algebra and Summary Statistics in R	Algebra of Matrices: ● The 'Matrix' package. ● Obtaining Determinants, Trace, Rank and Inverse of a Matrix. ● Obtaining row reduced forms of matrices, obtaining an orthonormal basis. ● Eigen Values and Eigen Vectors. ● Solving a system of equations. ● Diagonalisation of Matrices. Data Structures in R: ● Matrices: Creation, indexing, operations	CO2

		● Data Frames: Structure, accessing columns, rows; attach()/detach(), \$ operator ● Lists: Nested elements, accessing and modifying ● Interconversion between structures Data Import/Export: ● Reading and writing CSV/TSV/Text files: read.table(), read.csv(), write.csv() ● Header options, stringsAsFactors, saving/loading workspaces Summarizing Data: mean(), median(), sd(), var(), range(), summary() Conditional Filtering and logical subsetting Merging and Binding Data: cbind(), rbind(), merge() Handling Missing Values: is.na(), na.omit(), na.exclude()	
III	Data Visualization and Statistical Analysis	Graphics with Base R: ● plot(), lines(), points(), abline(), legend(), title() ● Diagram Types: Line, bar (vertical/horizontal), multiple bar, pie chart, subdivided bar chart ● Histogram, Boxplot, Cumulative Frequency Diagrams ● Setting graphical parameters using par() ● Descriptive Statistics: ● Univariate: Central tendency, dispersion, skewness, kurtosis (moments package)	CO3, CO4

		● Inferential Statistics: Confidence intervals, hypothesis testing (Z-test, t-test, chi-square), left/right/two-tailed tests, one-sample, two-sample, and paired-sample tests. ● Regression & ANOVA: Simple/multiple linear regression, ANOVA (one-way), residual analysis, model diagnostics.	
IV	Programming, Simulation & Applications in R	Control Structures: ● if, if-else, for, while, repeat User-defined Functions: Creating, arguments, return values Random Sampling and Simulations: ● <code>rnorm()</code>, <code>runif()</code>, <code>rbinom()</code>, <code>set.seed()</code> ● Simulations: Bias, MSE, confidence interval coverage, test power Optimization: ● <code>optim()</code> function and its applications File Handling: Import/export between R and other software formats (CSV, Excel, etc.)	C05

Suggested Readings:

Text Books:

1. Dalgaard, P. (2008): *Introductory Statistics with R*, Springer
2. Maindonald, J. & Braun, J. (2007): *Data Analysis and Graphics Using R*, Cambridge University Press

Reference

Materials:

3. Gardener, M. (2012): *Beginning R: The Statistical Programming Language*, Wiley
4. Faraway, J.J. (2006): *Linear Models with R*, Chapman & Hall/CRC
5. CRAN Manuals and R Documentation – <https://cran.r-project.org>

Teaching Pedagogy:

S. No.	Description	Used (Yes/No)
1	Lecture	Yes
2	Discussion/Demonstration	Yes
3	Case Study	Yes
4	Test/Assignment	Yes
5	Student Seminars/Presentation	Yes

CO-PO mapping:

CO/PO	PO1 (Critical Thinking)	PO2 (Effective Communication)	PO3 (Social Interaction)	PO4 (Effective Citizenship)	PO5 (Ethics)	PO6 (Environment and Sustainability)	PO7 (Self-directed and Life-long Learning)
CO1	H	L					H
CO2	H	M					H
CO3	H	M					H
CO4	H	M			L		H
CO5	H	M					H
Avg	3.0	1.6	0.0	0.0	0.2	0.0	3.0

*** **H** means High relevance, **M** means medium relevance, **L** means Low relevance

SEMESTER-IV

Course Name: Modern Indian Language (MIL II) – Hindi II

Course Type: Ability Enhancement Course.

Credit: 2 [Lecture: 2, Practical: 0].

COURSE CONTENT

UNIT-1 साहित्य (LITERATURE) (Marks allotted : 20)

कविता

- (1) प्रतिबद्ध हूँ - नागार्जुन
 - (2) भूख (सर्वेश्वर दयाल सक्सेना)
 - (3) धार्मिक दंगो की राजनीति- शमशेर बहादुर सिंह
- { तर्कसम्मत एवं समीक्षात्मक प्रश्न पूछे जाएंगे। }

UNIT-2 भाषा (LANGUAGE) (Marks allotted : 20)

विज्ञापन

- (1) विज्ञापन की परिभाषा, महत्व, भेद, उपयोगिता एवं प्रासंगिकता।
(2) विज्ञापन की भाषा।
(3) विज्ञापन लेखन।
{संक्षिप्त एवं व्यावहारिक प्रश्न पूछे जाएंगे।}

UNIT-3 दक्षता (SKILL) (Marks allotted : 10)

चलचित्र

- (1) अपठित गद्यांश
अथवा
(2) प्रतिवेदन लेखन
अथवा
(3) फिल्म समीक्षा कैसे की जाती है ?
{संक्षिप्त प्रश्न पूछे जाएंगे।}

SEMESTER-IV

Course Name: Modern Indian Language (MIL II) – Bengali-II

Course Type: Ability Enhancement Course.

Credit: 2 [Lecture: 2, Practical: 0].

COURSE CONTENT

Paper Structure – Continuous Internal Assessment (30%) + End Semester Examination (70%)

Continuous Internal Assessment – project/assignment/test, Mid-semester Examination, attendance

End Semester – Written examination

Credit Division – Unit 1: One credit, Unit II & III: One credit, Total: 2 credits.

Unit – I, Literature সাহিত্যপাঠ (20 Marks: Q1, A আধুনিক কবিতা / B আধুনিক ছোটগল্প)

A) আধুনিক কবিতা পাঠ:

১। অঙ্কুরিত আঁধার এক — জীবনানন্দ দাশ

২। মিছিলের মুখ — সুভাষ মুখোপাধ্যায়

৩। বাবরের প্রার্থনা — শঙ্খ ঘোষ

B) আধুনিক ছোটগল্প পাঠ:

১। পুঁই মাচা — বিভূতিভূষণ বন্দ্যোপাধ্যায়

২। হারানের নাতজামাই — মানিক বন্দ্যোপাধ্যায়

Unit – II, Language ভাষাপাঠ (20 Marks: Q2, A বোধপরীক্ষণ / B বিজ্ঞাপন লিখন / C চিত্রনাট্য লিখন)

Comprehension

A) বোধপরীক্ষণ – নির্বাচিত কোনো বাংলা সাহিত্য প্রবন্ধ থেকে নির্বাচিত অংশ বোধ-পরীক্ষণের জন্য উদ্ধৃত করে প্রশ্ন করা হবে।

Writing Skill

B) বিজ্ঞাপনের বয়ান রচনা: সংবাদপত্রে প্রকাশের উপযোগী বিজ্ঞাপনের খসড়া রচনা করতে হবে। (কর্মখালি, পণ্যের বিজ্ঞাপন ইত্যাদি)

অথবা

C) চিত্রনাট্য লিখন: গল্পাংশ অথবা প্রদত্ত পরিবেশ অনুসারে চিত্রনাট্য নির্মাণ করতে হবে, ৫টি দৃশ্য। চিত্রনাট্য নিয়ে সত্যজিৎ রায়ের লেখা ১। সিনেমার কথা, ২। চিত্রনাট্য ৩। চিত্রনাট্যের শৈলী প্রবন্ধগুলি পাঠ্য।

Unit – III, Skill দক্ষতা (10 marks: Q3, প্রফ সংশোধন)

A) প্রফ সংশোধন চিহ্ন [মূল পাঠ ও প্রফ পাঠের মধ্যে মিলিয়ে ভুল সংশোধন করে প্রফের চিহ্ন দিতে হবে]

SEMESTER-IV

Course Name: Business Communication II

Course Type: Ability Enhancement Course.

Credit: 2 [Lecture: 2, Practical: 0].

Course Outcomes (CO):

- CO1. Improve vocabulary skills by regularly engaging with newspapers, business news, and magazines to enhance business communication.
- CO2. Learn to analyze and present detailed information effectively in various types of business reports relevant to organizational requirements.
- CO3. Develop effective group discussion skills including active listening, argument formation, and minute-taking to contribute meaningfully in professional settings.
- CO4. Gain practical skills in drafting job applications, resumes, and formal letters, and prepare for interviews through mock sessions and guidance.
- CO5. Demonstrate the ability to integrate language and communication skills to produce clear, coherent, and context-appropriate presentations and documents.

COURSE CONTENT

SNo.	Module Name	Description	CO
I	Academic Vocabulary and English for Business Communication	Students are expected to read newspapers, business news, magazines to build vocabulary for the business communication. The reading material is provided by the faculty as and when required.	CO1, CO4
II	Business Report Writing	How to read the details and present them as a report especially in the organizational set up. Students are exposed to different nature and types of reports.	CO2, CO3
III	Group Discussion,	To participate in a group discussion a learner	CO4, CO5

	Types of Official Meetings and Minutes of a Meeting	requires patience to hear out what others are telling. Listening practice helps the students to grow as a good listener. The students are made to understand the nature of discussion in a group, difference between debate and discussion, ways to form and present the arguments and ways to defend themselves. The students are practically told to make groups and take down Minutes of the Meeting on a given topic; in the process they are taught the different types of business meetings, how to call for a meeting, how to organize it, maintain decorum and how to take down Minutes of the Meeting.	
IV	Job Applications, Resume Writing and Interview Skills	On the basis of Formal Letters, they are taught how to write applications for jobs with reference to advertisements; how to write offer letters for recruitment of employees and how to write resignation letters. The students are equipped with the entire process of acquiring a job with special reference to preparing a resume. They learn the skills of appearing in an interview and being successful in it.	CO1, CO3, CO4

Teaching Pedagogy:

S. No.	Description	Used (Yes/No)
1	Lecture	Yes
2	Discussion/Demonstration	Yes
3	Case Study	Yes
4	Test/Assignment	Yes
5	Student Seminars/Presentation	Yes

CO-PO mapping:

CO/PO	P01 (Critical Thinking)	P02 (Effective Communication)	P03 (Social Interaction)	P04 (Effective Citizenship)	P05 (Ethics)	P06 (Environment and Sustainability)	P07 (Self-directed and Life-long Learning)
C01	H	M	H				H
C02	H						H
C03	H						
C04	H	M	M		L		
C05	H	M	M	M	M		H
Avg	3.0	1.2	1.2	0.4	0.6	0.0	1.8

*** **H** means High relevance, **M** means medium relevance, **L** means Low relevance

SEMESTER-IV

Course Name: Internship

Course Type: Internship

Credit: 2

SEMESTER-V

Course Name: Numerical Methods and Optimization Techniques

Course Type: Discipline Specific Core

Credit: 4 [Lecture: 3, Practical: 1].

Course Outcomes (CO):

CO1: Understand numerical approximation of numbers and functions, and apply interpolation techniques such as Newton's and Lagrange's methods.

CO2: Apply numerical differentiation and integration techniques, and solve equations using fixed-point iteration and Newton-Raphson methods with error analysis.

CO3: Formulate and solve linear programming problems using simplex methods and understand duality and artificial variable techniques.

CO4: Solve transportation and assignment problems using methods like Vogel's Approximation, MODI, and the Hungarian algorithm.

CO5: Develop analytical and algorithmic thinking to solve real-life optimization problems using numerical methods and engage in further independent learning.

COURSE CONTENT

Module No.	Module Name	Chapter Topic	CO
I	Introduction to Numerical Methods	Approximation of numbers and functions. Absolute and Relative errors. Interpolation: Polynomial approximation of functions, Weierstrass Theorem (Statement). Factorial, finite differences and interpolation in numerical analysis. Operators, E and divided difference. Difference Table, Newton's forward and backward interpolation formulae. Lagrange's interpolation formula.	CO1, CO5
II	Numerical Differentiation and Integration, and iteration methods	Numerical Differentiation and its applications. Numerical integration. Trapezoidal rule, Simpson's one-third rule, with error terms. Numerical solution of equations: method of fixed-point iteration and Newton-Raphson method in one unknown, Conditions of convergence, rates of convergence. Extension of the iteration method to more than one unknowns (without proof of convergence).	CO2, CO5
III	Linear programming	Linear Programming Problem, Mathematical formulation of the L.P.P, graphical solutions of a L.P.P. in two decision variables. Simplex method for solving L.P.P. Charne's M-technique, two-phase technique. Concept of Duality in L.P.P. Dual simplex algorithm.	CO3, CO5
IV	Transportation and assignment problems	Transportation Problem: Initial feasible solution by North West corner rule, Least cost method and Vogel's approximation method (VAM), MODI's method to find the optimal solution. Assignment problem: Hungarian method to find optimal assignment.	CO4, CO5

Suggested Readings:

Text Books:

- 1 Mukherjee, Kr. Kalyan (1990): Numerical Analysis. New Central Book Agency, India.
2. Sastry, S.S. (2000): Introductory Methods of Numerical Analysis, 3rd edition, Prentice Hall of India Pvt. Ltd., New Delhi.
3. Hadley, G. (1969): Linear programming. Narosa Publishing House, New Delhi
4. Gass, S.I. (2003): Linear Programming: Methods and Applications: Fifth Edition. Dover Publications Inc.

Reference Books:

1. Jain, M. K., Iyengar, S. R. K. and Jain, R. K. (2003): Numerical methods for scientific and engineering computation, New age International Publisher, India.
2. Mittal, K.V. and Mohan, C. (2020): Optimization Methods in Operations Research and Systems Analysis. Fifth Edition. New Age International Private Limited, India.
3. Sharma, S.D. (2014): Operations Research – Theory, Methods and Applications. KNRN Publications, India.

List of Practicals:

1. Interpolation by Newton's forward and backward formulae, and Lagrange's formula.
2. Solving one- and 2- variable equations using Newton-Raphson method.
3. Trapezoidal and Simpson's 1/3rd rules for numerical integration with convergence.
4. Formulation of linear programming problems, and solving them.
- 5 Solving transportation and assignment problems.

Teaching Pedagogy:

S. No.	Description	Used (Yes/No)
1	Lecture	Yes
2	Discussion/Demonstration	Yes
3	Case Study	No
4	Test/Assignment	Yes
5	Student Seminars/Presentation	No

CO-PO mapping:

CO/PO	PO1 (Critical Thinking)	PO2 (Effective Communication)	PO3 (Social Interaction)	PO4 (Effective Citizenship)	PO5 (Ethics)	PO6 (Environment and Sustainability)	PO7 (Self-directed and Life-long Learning)
CO1	H	M	H	H	–	–	–
CO2	H	–	L	–	–	–	H
CO3	H	–	L	–	–	–	H
CO4	H	M	M	L	–	–	H
CO5	H	M	M	M	M	–	H
Avg	3.0	1.6	1.2	0.4	0.6	0.0	3.0

*** **H** means High relevance, **M** means medium relevance, **L** means Low relevance

SEMESTER-V

Course Name: Large Sample Theory and Nonparametric Inference.

Course Type: Discipline Specific Core.

Credit: 4 [Lecture: 3, Practical: 1].

Course Outcomes (CO):

CO1: Understand various modes of convergence for sequences of random variables and apply fundamental limit theorems.

CO2: Derive and interpret large sample approximations for distributions and standard errors of key statistics.

CO3: Apply large sample tests for means, proportions, correlations, and Pearsonian χ^2 -statistic in practical scenarios.

CO4: Explain and apply basic nonparametric tests for randomness, goodness of fit, and comparisons of location and scale.

CO5: Understand asymptotic properties of estimators and test statistics, including efficiency, likelihood-based methods, and density estimation.

COURSE CONTENT

Module No.	Module Name	Chapter Topic	CO
I	Limit Theorems and Modes of Convergence	Sequence of random variables: Definitions and examples Modes of convergence: ● Almost sure convergence ● Convergence in probability ● Convergence in distribution ● Convergence in mean square ● Interrelations and examples Weak Law and Strong Law of Large Numbers and applications Central Limit Theorem (CLT) for i.i.d. random variables (statement only) and its applications De Moivre–Laplace theorem (statement only)	CO1
II	Large Sample Approximations and Transformations	Delta method (univariate and multivariate (statement only)) and applications Large sample standard errors of: ● Sample moments ● Standard deviation ● Coefficient of variation ● Sample correlation coefficient ● Sample quantile Variance-stabilizing transformations:	CO2, CO3

		● Arcsin ($\sin^{-1}$), square root, log, Fisher's z-transform Large sample tests: ● Binomial proportions (one and two samples) ● Poisson means (one and two samples) ● Correlation coefficient Large sample distribution of Pearsonian χ^2 statistic and applications in goodness of fit	
III	Nonparametric Tests	Concept of nonparametric inference and advantages Run test for randomness Empirical Distribution Function (EDF): definition and use One-sample tests: ● Kolmogorov–Smirnov (K–S) test ● Sign test ● Wilcoxon signed-rank test Two-sample tests: ● Wilcoxon–Mann–Whitney test ● Median test ● Kruskal–Wallis test (for multiple samples)	CO4

IV	Asymptotics	● Concepts of consistency and asymptotic efficiency of estimators ● Large sample properties of Maximum Likelihood Estimators (MLEs) ● Asymptotic confidence intervals based on MLEs ● Likelihood Ratio Test (LRT): asymptotic distribution and properties (simple null) ● Wald's test and Rao's score test	C05
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Suggested Readings:

Text Books:

1. Goon, A.M., Gupta, M.K., Dasgupta, B. (2002). Fundamentals of Statistics, Vol. I, 8th Edn., The World Press, Kolkata.
2. Rohatgi, V.K., Saleh, A.K. Md. E. (2009). An Introduction to Probability and Statistics, 2nd Edn. (Reprint), John Wiley & Sons.

Reference Books:

3. Casella, G., Berger, R.L. (2002). Statistical Inference, 2nd Edn., Duxbury.
4. Dudewicz, E.J., Mishra, S.N. (1988). Modern Mathematical Statistics, Wiley.
5. Mood, A.M., Graybill, F.A., Boes, D.C. (1974). Introduction to the Theory of Statistics, McGraw-Hill.
6. Miller, I., Miller, M. (2002). John E. Freund's Mathematical Statistics, Prentice Hall.
7. R.J. Serfling (1980). Approximation Theorems of Mathematical Statistics, Wiley.
8. E.L. Lehmann (1999). Elements of Large-Sample Theory, Springer.

9. A.W. van der Vaart (1998). Asymptotic Statistics, Cambridge University Press.
10. Hettmansperger, T.P. (1984). Statistical Inference Based on Ranks, Wiley.
11. Gibbons, J.D. and Chakraborti, S. (2011). Nonparametric Statistical Inference, Fourth Edition, Revised and Expanded, CRC Press.

List of Practicals

1. Illustration of convergence modes using simulated sequences
2. Applying CLT to estimate distribution of sample means
3. Estimation and use of large sample standard errors
4. Using transformations to stabilize variance
5. Conducting large sample z-tests for means and proportions
6. Large sample test using Pearsonian χ^2
7. Performing nonparametric tests: sign test, signed-rank, K-S test
8. Wilcoxon-Mann-Whitney and Kruskal-Wallis tests on real datasets
9. Calculating ARE between different tests
10. Demonstration of likelihood ratio, Wald, and score tests

Teaching Pedagogy:

S. No.	Description	Used (Yes/No)
1	Lecture	Yes
2	Discussion/Demonstration	Yes
3	Case Study	Yes
4	Test/Assignment	Yes
5	Student Seminars/Presentation	Yes

CO-PO mapping:

CO/PO	PO1 (Critical Thinking)	PO2 (Effective Communication)	PO3 (Social Interaction)	PO4 (Effective Citizenship)	PO5 (Ethics)	PO6 (Environment and Sustainability)	PO7 (Self-directed and Life-long Learning)
CO1	H	M					H
CO2	H	M					H
CO3	H	M			L		H
CO4	H	M	L		L		H
CO5	H	L			M		H
Avg	3.0	1.8	0.2	0.0	0.6	0.0	3.0

*** **H** means High relevance, **M** means medium relevance, **L** means Low relevance

Semester-V

Course Name: Regression Analysis

Course Type: Discipline Specific Core

Credits: 4 [Lecture: 3, Practical: 1]

COURSE CONTENT:

Module No.	Module Name	Chapter Topic	CO
I	Introduction to Linear Regression	Review of Simple Linear Regression and Multiple Linear Regression, Transformation of Variables	C01, C05

		Dummy Variables	
II	Diagnostics and Remedial Measures	Residual Analysis: Residual plots, Scaling residuals: Standardized and Studentized Residuals, Residual plots, Outlier and leverage diagnostics DFBETA, DFFITS and Cook's Distance. Lack-of-fit tests in regression models	C02, C05
III	Model Building and Selection	Model Building: Problems in model building, model misspecification and its impact. Variable selection techniques: subset selection methods: all possible regressions, stepwise selection. Criteria for evaluating models: R^2 , adjusted R^2 . Multicollinearity: • Concept of multicollinearity • detection and steps to remove multicollinearity	C03, C05
IV	Regression models for binary response	Linear Probability Model (LPM), Logit and Probit models. Estimation of parameters for arrayed responses.	C04, C05

Suggested Readings

Textbooks:

- Draper, N. R. and Smith, H. (1998): *Applied Regression Analysis*, 3rd Ed. John Wiley and Sons.
- Chatterjee, S., & Hadi, A. S. (2006). *Regression analysis by example* (4th ed.). Wiley.
- Belsley, D. W., Kuh, E., & Welsch, R. E. (1980). *Regression diagnostics: Identifying influential data and sources of collinearity*. Wiley.
- Johnston, J. (1984). *Econometric methods* (3rd ed.). McGraw-Hill.

Reference Books:

- Weisberg, S. (2014). *Applied linear regression* (4th ed.). Wiley.
- Montgomery, D.C., Peck, E.A., & Vining, G.G. (2012). *Introduction to Linear Regression Analysis*, Wiley.
- Ryan, T. P. (2008). *Modern regression methods* (2nd ed.). Wiley.
- Faraway, J. J. (2006). *Linear models with R*. CRC Press.

- Kutner, M. H., Nachtsheim, C. J., Neter, J., & Li, W. (2005). *Applied linear statistical models* (5th ed.). McGraw-Hill/Irwin.
- Judge, G. G., Griffiths, W. E., Hill, R. C., Lütkepohl, H., & Lee, T.-C. (1985). *The theory and practice of econometrics* (2nd ed.). Wiley.
- Cook, R. D., & Weisberg, S. (1982). *Residuals and influence in regression*. Chapman and Hall.

List of Suggested Practical:

- Fitting and interpreting linear regression models.
- Diagnostics: residual plots, multicollinearity (VIF), Cook's D, etc.
- Model selection using statistical criteria and stepwise methods.
- Detection and Remedy for Multicollinearity
- Regression with dummy variables.
- Logistic regression with real data.

Teaching Pedagogy:

S. No.	Description	Used (Yes/No)
1	Lecture	Yes
2	Discussion/Demonstration	Yes
3	Case Study	Yes
4	Test/Assignment	Yes
5	Student Seminars/Presentation	Yes

CO-PO Mapping:

CO/PO	P01 (Critical Thinking)	P02 (Effective Communication)	P03 (Social Interaction)	P04 (Effective Citizenship)	P05 (Ethics)	P06 (Environment and Sustainability)	P07 (Self-directed and Life-long Learning)

C01	H	M	H				H
C02	H	L					H
C03	H	L					H
C04	H	M	M		L		H
C05	H	M	H	M	M		H
Avg	3.0	1.6	1.6	0.4	0.6	0.0	3.0

*** **H** means High relevance, **M** means medium relevance, **L** means Low relevance

Semester-V

Course Name: Statistical Quality Control and Vital Statistics

Course Type: Discipline Specific Core

Credit: 4 [Lecture: 3, Practical: 1].

Course Content:

Module No.	Module Name	Chapter Topic	CO
I	Introduction to Quality Control	Definition of quality, dimensions of quality. Quality system and standards: Introduction to ISO quality standards, Statistical Process Control - Seven tools of SPC, chance and assignable causes of quality variation. Statistical Control Charts- Construction and Statistical basis of 3σ Control charts, Rational Sub-grouping. Statistical product control – sampling inspection plans.	C01, C02
II	Control charts and sampling inspection plans	Control charts for attributes: np-chart, p-chart, c-chart and u-chart. Control charts for variables: X-bar chart, R-chart, s-chart. Analysis of patterns on control chart. Acceptance sampling plan: Principle of acceptance sampling plans. Single and Double sampling plans, their OC, AQL, LTPD, AOQ, AOQL, ASN, ATI functions with graphical interpretation. Use of Dodge and Romig's sampling inspection plan tables.	C02
III	Measurement of Vital	Vital events, Rates and Ratios, Measurement of Mortality –	C01,

	Statistics and Demographic Rates	Crude, Specific and Standardized death rates, Measurements of Fertility: Crude Birth Rate (CBR), General Fertility Rate (GFR), Specific Fertility Rate (SFR) and Total Fertility Rate (TFR). Measurement of Population Growth: Crude rates of natural increase, Gross Reproduction Rate (GRR) and Net Reproduction Rate (NRR)	C03
IV	Life Table Techniques	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. Complete Life Table, Abridged Life Tables: Concept and construction of abridged life tables.	C03, C04, C05

Suggested Readings:

Textbooks:

1. Montgomery, D. C. (2020): Introduction to Statistical Quality Control, 8th Edition, Wiley India Pvt. Ltd.
2. Goon A.M., Gupta M.K. and Dasgupta B. (2002): Fundamentals of Statistics, Vols. I& II, 8th Edition, The World Press, Kolkata.
3. Montgomery, D. C. and Runger, G.C. (2008): Applied Statistics and Probability for Engineers, 3rd Edition reprint, Wiley India Pvt. Ltd.
4. Hoyle, David (1995): ISO Quality Systems Handbook, 2nd Edition, Butterworth Heinemann Publication.
5. Croxton, Fredrick E., Cowden, Dudley J. and Klein, S. (1973): Applied General Statistics, 3rd Edition. Prentice Hall of India Pvt. Ltd.
6. Keyfitz N., Beckman John A.: Demography through Problems S-Verlag New york.
7. Biswas, S. (1988). Stochastic Processes in Demography & Application, Wiley Eastern Ltd.

Reference Books:

1. Mukhopadhyay, P (2011): Applied Statistics, 2nd edition revised reprint, Books and Allied(P) Ltd.
2. Amitava Mitra (2013): Fundamentals of Quality Control and Improvement. 3rd Edition. John Wiley and Sons, Inc.
3. Croxton, Fredrick, E. Cowden, Dudley J. and Klein, S. (1973). Applied General Statistics, 3rd Ed., Prentice Hall of India Pvt. Ltd. 3.

List of Suggested Practicals:

1. Construction and interpretation of statistical control charts: X-bar, R-chart, 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. To calculate CDR and Age Specific death rate for a given data set.

4. To find standardized death rate by: (i) Direct method (ii) Indirect method.

5. To construct a complete life table.

6. To calculate probabilities of death at pivotal ages and use it to construct abridged life table

8. To calculate CBR, GFR, SFR, TFR for a given data set.

9. To calculate Crude rate of Natural Increase for a given data set.

10. Calculate GRR and NRR for a given set of data and compare them.

Teaching Pedagogy:

S. No.	Description	Used (Yes/No)
1	Lecture	Yes
2	Discussion/Demonstration	Yes
3	Case Study	No
4	Test/Assignment	Yes
5	Student Seminars/Presentation	Yes

CO-PO mapping:

CO/PO	PO1 (Critical Thinking)	PO2 (Effective Communication)	PO3 (Social Interaction)	PO4 (Effective Citizenship)	PO5 (Ethics)	PO6 (Environment and Sustainability)	PO7 (Self-directed and Life-long Learning)
CO1	H	M					H
CO2	H	M					H
CO3	H	M					H
CO4	H	M			L		H
CO5	H	M		L	M		H
Average	3.0	2.0	0.0	0.2	0.6	0.0	3.0

*** **H** means High relevance, **M** means medium relevance, **L** means Low relevance

Semester-V

Course Name: **Artificial Intelligence**

Credit: 4, [Lecture: 2, Practical: 2]

Course Outcomes (CO):

CO1: Understand the foundational concepts, history, applications, and ethical implications of AI.

CO2: Apply problem-solving and search strategies for AI-based solutions.

CO3: Explain and apply logical and probabilistic knowledge representation techniques.

CO4: Understand fuzzy and rough set theory and apply them in decision-making contexts.

CO5: Implement basic AI algorithms and reasoning systems using Python-based tools.

COURSE CONTENT

Module No.	Module Name	Chapter Topic	CO
I	Introduction	Introduction to Artificial Intelligence, Brief History and Application, Definition and Scope of AI, Importance of AI in various fields like education, healthcare, medicine, environment etc., Advantages and disadvantages of AI, AI as a superset of Machine Learning, Data Science and Deep Learning, Ethical and social issues in AI	CO1
II	Problem Solving and Search Techniques	State space search, problem formulation, Uninformed Search: BFS, DFS, Iterative Deepening, Informed Search: Best-First Search, A* Algorithm, Constraint Satisfaction Problems, Game Playing: Minimax and Alpha-Beta Pruning	CO2, CO5
III	Knowledge Representation and Reasoning	Propositional and Predicate Logic, Rule-Based Systems Forward and Backward Chaining, Probabilistic Reasoning and Bayesian Networks (Introductory concepts)	CO3, CO5
IV	Fuzzy and Rough set	Fuzzy sets, application – basic operations, Properties, Fuzzy Relations, Fuzzy inference, Notion of Fuzziness, Operations on Fuzzy sets, composition of fuzzy relation, Different methods of role aggregation and defuzzification. Rough set, positive region, negative region and boundary region, Basic difference between Rough sets and Fuzzy sets	CO4

Suggested Readings:

Text Books:

1. Stuart Russell & Peter Norvig, Artificial Intelligence: A Modern Approach Publisher: Pearson
2. Elaine Rich, Kevin Knight & Shivashankar B. Nair, Artificial Intelligence
Publisher: Tata McGraw-Hill
3. George J. Klir & Bo Yuan *Fuzzy Sets and Fuzzy Logic: Theory and Applications*
Publisher: Prentice Hall of India
4. Zdzisław Pawlak, Rough Sets: Theoretical Aspects of Reasoning About Data
Publisher: Springer
5. Artificial Intelligence and Soft Computing: Behavioral and Cognitive Modeling of the Human Brain, Amit Konar (Jadavpur University) Publisher: Taylor & Francis (CRC Press), 1999

6. Principles of Soft Computing Authors: S. N. Sivanandam & S. N. Deepa
Publisher: Wiley India, 2007

Teaching Pedagogy:

S. No.	Description	Used (Yes/No)
1	Lecture	Yes
2	Discussion/Demonstration	Yes
3	Case Study	Yes
4	Test/Assignment	Yes
5	Student Seminars/Presentation	Yes

Suggested list of Practical's using Python

1. Implement Breadth-First Search (BFS) and Depth-First Search (DFS) algorithms in Python.
2. Write a Python program to implement Iterative Deepening Search.
3. Develop an A* Search algorithm using an appropriate heuristic function for a graph-based problem.
4. Simulate a simple two-player game (e.g., Tic-Tac-Toe) using the Minimax algorithm with Alpha-Beta pruning.
5. Solve a Constraint Satisfaction Problem such as N-Queens or Sudoku using backtracking in Python.
6. Create a Python program that evaluates logical expressions using propositional logic and generates truth tables.
7. Develop a simple Bayesian reasoning model for medical diagnosis or classification using Python.
8. Design a fuzzy inference system to evaluate student performance or weather conditions using Python or MATLAB.
9. Apply defuzzification techniques such as centroid, bisector, and mean of maxima in a fuzzy inference system.
10. Implement a basic rough set model to identify positive, negative, and boundary regions from a sample dataset.

CO-PO mapping:

CO/PO	PO1 (Critical Thinking)	PO2 (Effective Communication)	PO3 (Social Interaction)	PO4 (Effective Citizenship)	PO5 (Ethics)	PO6 (Environment and Sustainability)	PO7 (Self-directed and Life-long Learning)
CO1	H	H	H	H	H		
CO2	M	M	H	M		H	M
CO3	M	H	M	M	M		M
CO4	H	M	M	M			M
CO5	M	M	M	M		M	M
Average	2.4	2.4	2.4	2.2	1	1	1.6

SEMESTER-VI

Course Name: Statistical Inference-III.

Course Type: Discipline Specific Core.

Credit: 4 [Lecture: 3, Practical: 1].

Course Outcomes (CO):

CO1: Understand and apply parametric inference techniques such as Neyman–Pearson Lemma and its extensions to construct optimal tests.

CO2: Apply the theory of U-statistics and linear rank statistics in common nonparametric testing problems.

CO3: Analyze the asymptotic properties of statistical tests including LRT, Wald, and Rao’s score test.

CO4: Implement and interpret permutation-based methods and understand their role in exact and approximate inference.

CO5: Apply resampling techniques such as jackknife and bootstrap for estimating bias, variance, distribution functions, and constructing confidence intervals.

COURSE CONTENT

Module No.	Module Name	Chapter Topic	CO
I	Parametric Inference	● Review of Fundamental Neyman–Pearson Lemma with detailed proofs. Typical examples ● UMP tests and Monotone Likelihood Ratio (MLR) ● Karlin–Rubin theorem and applications ● Generalized Neyman–Pearson Lemma ● Concepts of α-similarity and α-Neyman structure ● UMPU tests for simple and composite hypotheses	CO1

		● Applications in one-parameter exponential family and k-parameter exponential family	
II	Nonparametric Statistics	U-statistics: definition, properties, asymptotic behaviour Linear Rank Statistics (LRS): introduction and use in hypothesis testing Applications to: ● Single sample location and location with symmetry ● Goodness-of-fit problems ● Two-sample problems: location, scale, homogeneity ● Multi-sample location problem ● Bivariate association problem Connection to earlier known nonparametric tests (Sign, Wilcoxon, Kolmogorov-Smirnov, etc.) Density estimation	CO2

III	Asymptotic Inference and Efficiency	Concepts of asymptotic relative efficiency (ARE). Introduction to permutation tests and their theoretical justification	CO3, CO4
IV	Resampling Techniques	Introduction to resampling-based inference Jackknife method: ● Estimation of bias and standard error ● Examples: sample mean, correlation coefficient, etc. Bootstrap method: ● Estimation of bias, variance, and distribution ● Bootstrap confidence intervals: percentile, bias-corrected, accelerated (BCa) Applications of jackknife and bootstrap in real-life data analysis	CO5

Suggested Readings:

1. Goon, A.M., Gupta, M.K., Dasgupta, B. (2005). Outline of Statistics, Vol. I & II, World Press.
2. Rohatgi, V.K., Saleh, A.K. Md. E. (2009). An Introduction to Probability and Statistics, Wiley.
3. Casella, G., Berger, R.L. (2002). Statistical Inference, 2nd Ed., Duxbury.
4. Dudewicz, E.J., Mishra, S.N. (1988). Modern Mathematical Statistics, Wiley.
5. Mood, A.M., Graybill, F.A., Boes, D.C. (1974). Introduction to the Theory of Statistics, McGraw-Hill.
6. Miller, I., Miller, M. (2002). John E. Freund's Mathematical Statistics, Prentice Hall.
7. B. Efron & R.J. Tibshirani (1993). An Introduction to the Bootstrap, Chapman & Hall/CRC.
8. B. Efron (1982). The Jackknife, the Bootstrap, and Other Resampling Plans, SIAM.
9. J. Shao & D. Tu (1995). The Jackknife and Bootstrap, Springer.
10. Hettmansperger, T.P. (1984). Statistical Inference Based on Ranks, Wiley.
11. Gibbons, J.D. and Chakraborti, S. (2011). Nonparametric Statistical Inference, Fourth Edition, Revised and Expanded, CRC Press.

List of Practicals:

1. Simulation of asymptotic properties of LRT, Wald, and Rao's Score tests
2. Implementation of permutation tests for mean and median
3. Jackknife estimation for bias and variance
4. Bootstrap methods for estimating standard error and constructing confidence intervals
5. Comparing the performance of parametric and nonparametric tests
6. Density estimation via kernel methods

Teaching Pedagogy:

S. No.	Description	Used (Yes/No)
1	Lecture	Yes
2	Discussion/Demonstration	Yes
3	Case Study	Yes
4	Test/Assignment	Yes
5	Student Seminars/Presentation	Yes

CO-PO mapping:

CO/PO	P01 (Critical Thinking)	P02 (Effective Communication)	P03 (Social Interaction)	P04 (Effective Citizenship)	P05 (Ethics)	P06 (Environment and Sustainability)	P07 (Self-directed and Life-long Learning)

CO1	H	M					H
CO2	H	M					H
CO3	H	L			M		H
CO4	H	M			L		H
CO5	H	M					H
Avg	3.0	1.6	0.0	0.0	0.6	0.0	3.0

*** **H** means High relevance, **M** means medium relevance, **L** means Low relevance

SEMESTER-VI

Course Name: Statistical Decision Theory and Bayesian Inference.

Course Type: Discipline Specific Core.

Credit: 4 [Lecture: 3, Practical: 1].

Course Outcomes (CO):

CO1: Understand and analyze decision functions, loss functions, risk, and utility in statistical decision-making.

CO2: Evaluate optimality criteria such as admissibility, Bayes and minimax principles, and complete class theorems.

CO3: Apply foundational principles of Bayesian inference for estimation, testing, and prediction in standard statistical models.

CO4: Compare classical and Bayesian paradigms and understand the use of priors, hierarchical models, and real-world implications.

CO5: Implement Bayesian inference using Stan and RStan for practical computation, including writing models and generating posterior summaries.

COURSE CONTENT

Module No.	Module Name	Chapter Topic	CO
I	Foundations of Statistical Decision Theory	● Decision problems, action space, loss and utility functions, risk functions ● Non-randomized vs randomized rules ● Concepts of admissibility, dominance, complete and essentially complete classes ● Sufficiency and convex loss, risk reduction using sufficient statistics ● Decision problems as two-person games ● Sequential and multiple decision problems	CO1, CO2
II	Bayes and Minimax Decision Rules	Bayes rules and generalized Bayes rules Extended and limiting Bayes rules Admissibility of Bayes rules Minimax principles and minimax rules Techniques to find minimax rules Invariant decision rules Applications in estimation and testing	CO1, CO2

III	Foundations of Bayesian Inference	Comparison between classical and Bayesian paradigms Subjective probability and prior beliefs Prior, posterior, and predictive distributions Conjugate priors for standard families: binomial, Poisson, exponential, normal Interval estimation, hypothesis testing, and prediction under Bayesian framework Simple hierarchical Bayes models	CO3, CO4
IV	Bayesian Computation with Stan	Introduction to probabilistic programming and Stan Syntax of Stan: defining models, functions, data blocks Using RStan for Bayesian analysis in R Sampling from posterior distribution Posterior summaries, diagnostics, trace plots, convergence Applications: simple problems from previous units (e.g., coin toss, Poisson rate, regression)	CO4, CO5

Suggested Readings:

1. Berger, J.O. (1985). *Statistical Decision Theory and Bayesian Analysis*, 2nd Ed., Springer.
2. Ferguson, T.S. (1967). *Mathematical Statistics: A Decision Theoretic Approach*, Academic Press.

3. Ghosh, J.K., Delampady, M., Samanta, T. (2006). *An Introduction to Bayesian Inference*, Springer.
4. Lee, P.M. (2012). *Bayesian Statistics: An Introduction*, Wiley.
5. Gelman, A., Carlin, J.B., Stern, H.S., Dunson, D.B., Vehtari, A., Rubin, D.B. (2013). *Bayesian Data Analysis*, 3rd Ed., CRC Press.
6. Robert, C.P. (2007). *The Bayesian Choice*, 2nd Ed., Springer.

List of Practicals

1. Perform Bayesian parameter estimation with informative and non-informative priors
2. Simulate posterior distributions in R using basic MCMC
3. Model real-life problems in Stan (e.g., disease incidence, failure rates, Bayesian regression)
4. Build a hierarchical Bayesian model in RStan
5. Compare posterior estimates from Stan with classical estimates

Teaching Pedagogy:

S. No.	Description	Used (Yes/No)
1	Lecture	Yes
2	Discussion/Demonstration	Yes
3	Case Study	Yes
4	Test/Assignment	Yes
5	Student Seminars/Presentation	Yes

CO-PO mapping:

CO/PO	P01 (Critical Thinking)	P02 (Effective Communication)	P03 (Social Interaction)	P04 (Effective Citizenship)	P05 (Ethics)	P06 (Environment and Sustainability)	P07 (Self-directed and Life-long Learning)
C01	H	M	L				H
C02	H	M	L				H
C03	H	M	L		M		H
C04	H	M	L		L		H
C05	H	M	L				H
Avg	3.0	2.0	1.0	0.0	0.6	0.0	3.0

*** **H** means High relevance, **M** means medium relevance, **L** means Low relevance

Semester-VI

Course Name: Sample Survey-I and Design of experiments-I

Course Type: Discipline Specific Core

Credit: 4 [Lecture: 3, Practical: 1]

COURSE CONTENT:

Module No.	Module Name	Chapter Topic	CO
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I	Basics of Sampling and Probability-Based Survey Methods	• Concepts of finite population and sample • Need for sampling and its advantages over complete enumeration • Types of errors: Sampling vs. Non-sampling errors, Bias and variance trade-offs, • Types of sampling techniques: Non-probability and Probability sampling • Basic principles of sample survey, • Different steps involved in a large-scale sample survey • Tables of random numbers and their use in random selection. Simple Random Sampling (SRS): • With and without replacement • Unbiased estimators of population mean, total, and proportion • Variances of these estimators and their unbiased variance estimators Stratified Random Sampling: • Concept, advantages, and method • Estimators of population mean and total, their variances • Proportional and optimum allocation, and their comparison with SRS • Practical challenges in allocation	C01, C02
II	Other types of Sampling procedures	Cluster Sampling (Equal-sized clusters): • Definition and method • Estimation of population mean and variance Subsampling Concepts: • Introduction to two-stage sampling • Estimation of population mean and variance when the sizes of the first stage units are equal, and samples are selected by SRS in the two stages	C02, C04

III	Introduction to Design of Experiments and Basic Designs	Introduction and Fundamental Concepts • Role and importance of Design of Experiments in scientific studies • Key terminologies: Treatments, Experimental Units, Blocks, Experimental Error • Basic principles of experimental design: Replication, Randomization, and Local Control Design Planning in Agricultural and Industrial Settings • Uniformity trials and fertility contour maps • Choice of size and shape of plots and blocks in agricultural experiments • Applications of DOE in industrial experimentation Basic Experimental Designs • Completely Randomized Design (CRD) • Randomized Block Design (RBD) • Latin Square Design (LSD) ○ Layout, mathematical model, statistical analysis ○ Relative efficiency comparison among CRD, RBD, and LSD Analysis with one missing observation in RBD and LSD	C03
IV	Factorial and Special Experimental Designs	Factorial Experiments • Advantages and applications • Notation and concepts for factorial designs • 2ⁿ factorial experiments (n=2,3): layout, design, and analysis • Confounding in factorials: ○ Total and partial confounding ○ Concept of factorial experiments in a single replicate	C05

Suggested Readings:

Textbooks:

- Raj, D. (1968). *Sampling theory*. McGraw-Hill.
- Sukhatme, P. V., Sukhatme, B. V., Sukhatme, S., & Asok, C. (1970). *Sampling theory of surveys with applications* (pp. 27-29). Ames, IA: Iowa state university press.

- Dean, A., & Voss, D. (Eds.). (1999). *Design and analysis of experiments*. New York, NY: Springer New York.
- Goon, A.M., Gupta, M.K. and Dasgupta, B. (2005): *Fundamentals of Statistics*. Vol. II, 8thEdn. World Press, Kolkata.
- Montgomery, D. C. (2008): *Design and Analysis of Experiments*, John Wiley.

Reference Books:

- Cochran, W. G. (1977). *Sampling techniques*. John Wiley & Sons.
- Murthy, M. N. (1967). *Sampling theory and methods*. Statistical Publishing Society.
- Cochran, W.G. and Cox, G.M. (1959): *Experimental Design*. Asia Publishing House.
- Das, M.N. and Giri, N.C. (1986): *Design and Analysis of Experiments*. Wiley Eastern Ltd.
- Kempthorne, O. (1965): *The Design and Analysis of Experiments*. John Wiley.
- Wu, C. J., & Hamada, M. S. (2011). *Experiments: planning, analysis, and optimization*. John Wiley & Sons.

List of Suggested Practicals:

1. To draw 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
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. Cluster sampling: estimation of mean or total, variance of the estimate.
7. Problems on CRD, RBD, LSD, and 2^2 , 2^3 factorial designs.

Teaching Pedagogy:

S. No.	Description	Used (Yes/No)
1	Lecture	Yes
2	Discussion/Demonstration	Yes
3	Case Study	Yes
4	Test/Assignment	Yes
5	Student Seminars/Presentation	Yes

CO-PO Mapping:

CO/PO	PO1 (Critical Thinking)	PO2 (Effective Communication)	PO3 (Social Interaction)	PO4 (Effective Citizenship)	PO5 (Ethics)	PO6 (Environment and Sustainability)	PO7 (Self-directed and Life-long Learning)
C01	H	M	L		L		M
C02	H	M	L		M		H
C03	H	M	M		L		H
C04	H	M	L		L		M
C05	H	M	M		M		M
Avg	3.0	2.0	1.4	0.0	1.4	0.0	2.4

*** **H** means High relevance, **M** means medium relevance, **L** means Low relevance

Semester- VI

Course Name: Time Series Analysis-I and Econometrics-I

Course Type: Discipline Specific Core

Credit: 4 [Lecture: 3, Practical: 1]

Course Contents:

Module No.	Module Name	Chapter Topic	CO
I	Descriptive Analysis of Time Series Data	Components of a time series (trend, seasonal, cyclical and irregular variations) Additive and multiplicative models Estimation of trend: - Measurement of trend by method of free-hand curve, method of moving averages, - fitting various mathematical curves (linear, quadratic and modified exponential). Measurement of seasonal variations: - Method of Ratio to Trend	C01, C05

		Method of Simple Averages,	
II	Stochastic Time Series Models and Forecasting Techniques	Introduction to stochastic modelling: - Concept of stationarity. - Illustration of how a stationary time series may show temporal patterns. Box-Jenkins modelling: - Moving-average (MA) process and Autoregressive (AR) process of orders one and two. - ACF and its graphical use in guessing the order of MA processes. - Estimation of the parameters of AR (1) and AR (2) using least square and Yule-Walker equations. Forecasting: Exponential smoothing method	CO2, CO5
III	Introduction to Econometric Modelling	Objective behind building econometric models, nature of econometrics, model building, role of econometrics..	CO3
IV	Diagnostic Testing and Remedial Measures in Econometric Analysis	Autocorrelation: - Concept and consequences of auto correlated disturbances - detection and solution of autocorrelation - Generalized least squares estimation Heteroscedastic disturbances: - Concepts and consequences of heteroscedasticity. - Tests and solutions of heteroscedasticity.	CO4, CO5

Suggested Readings:

Textbooks:

- Chatfield C. (1980): The Analysis of Time Series –An Introduction, Chapman & Hall.
- Box, G. E., Jenkins, G. M., Reinsel, G. C., & Ljung, G. M. (2015). *Time series analysis: forecasting and control*. John Wiley & Sons.
- Johnston, J. (1972): Econometric Methods, 2nd Edition, McGraw Hill International.
- Gujarati, D. and Sangeetha, S. (2007): Basic Econometrics, 4th Edition McGraw Hill Companies

Reference books:

- Koutsoyiannis, A. (2004): Theory of Econometrics, 2nd Edition, Palgrave Macmillan Limited
- Maddala, G.S. and Lahiri, K. (2009): Introduction to Econometrics, 4th Edition, John Wiley & Sons.
- Brockwell, P. J., & Davis, R. A. (2010). Introduction to time series and forecasting (2nd ed.). Springer.

- Kendall M.G. (1976): Time Series, Charles Griffin.

List of suggested practicals:

- Decomposition of Time Series models
- Estimation of Trend by Moving Averages
- Fitting of Linear and Quadratic Trends
- Estimation of Seasonal Indices
- Exponential Smoothing Techniques
- Fitting AR(1), AR(2), and MA(1) Models
- Estimation of a Simple Linear Regression Model
- Detection and Treatment of Autocorrelation
- Detection and Treatment of heteroscedasticity

Teaching Pedagogy:

S. No.	Description	Used (Yes/No)
1	Lecture	Yes
2	Discussion/Demonstration	Yes
3	Case Study	Yes
4	Test/Assignment	Yes
5	Student Seminars/Presentation	Yes

CO-PO mapping:

CO/PO	PO1 (Critical Thinking)	PO2 (Effective Communication)	PO3 (Social Interaction)	PO4 (Effective Citizenship)	PO5 (Ethics)	PO6 (Environment and Sustainability)	PO7 (Self-directed and Life-long Learning)

C01	H	M	M	L		M	H
C02	H	L	L	L		L	H
C03	H	L	L	M		M	H
C04	H	M	M	L	L	L	H
C05	H	M	M	M	M	L	H
Avg	3.0	1.6	1.6	1.4	0.6	1.4	3.0

*** **H** means High relevance, **M** means medium relevance, **L** means Low relevance

SEMESTER-VI

Course Name: Machine Learning with R/Python.

Course Type: Minor.

Credit: 4 [Lecture: 2, Practical: 2].

COURSE CONTENT

Module No.	Module Name	Chapter Topic	CO
I	Supervised Learning – Regression & Classification	● Supervised vs. Unsupervised learning ● Linear Regression: simple and multiple, cost function, gradient descent ● Polynomial Regression and Feature Engineering ● Logistic Regression for binary classification ● Regularization techniques: Ridge, Lasso ● Evaluation Metrics: MSE, MAE, Accuracy, Precision, Recall, F1	C01

		● Implementation using scikit-learn (Python) and caret/tidymodels (R)	
II	Machine Learning Algorithms	Discriminant Analysis: Bayes Rule, Minimax Rule, Likelihood Ratio, Multivariate Normal classification; Misclassification rates. LDA/QDA Introduction to Decision Trees and Random Forests Feature selection and model tuning (grid search, cross-validation) Overfitting and underfitting: bias-variance tradeoff Implementation in scikit-learn, and randomForest (R)	CO2
III	Unsupervised Learning and Dimensionality Reduction	Clustering Techniques: ● Hierarchical clustering (agglomerative, divisive) ● K-means clustering, Silhouette Index Introduction to Principal Component Analysis (PCA): ● Population/sample PCs, Biplots, Large sample inference ● Use of cluster, factoextra, recommenderlab (R), and sklearn.decomposition, surprise (Python)	CO3

IV	Case Studies & Project	End-to-end ML workflow: EDA, preprocessing, modeling, evaluation Case studies from health, finance, marketing, sports analytics Recommender Systems (item-based, user-based) Kaggle-style mini-projects using real datasets Best practices for reproducibility and presentation Group project: presentation, code, and report submission	CO4, CO5
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Suggested Readings:

1. Hastie, T., Tibshirani, R., Friedman, J. (2009). *The Elements of Statistical Learning*, 2nd Edn., Springer.
2. James, G., Witten, D., Hastie, T., Tibshirani, R. (2013). *An Introduction to Statistical Learning: With Applications in R*, Springer.
3. Guido, S., Müller, A.C. (2016). *Introduction to Machine Learning with Python: A Guide for Data Scientists*, O'Reilly Media.
4. McKinney, W. (2012). *Python for Data Analysis*, O'Reilly Media.
5. Wickham, H., Golemund, G. (2016). *R for Data Science*, O'Reilly Media.
6. Chollet, F. (2017). *Deep Learning with Python*, Manning Publications.
7. Lantz, B. (2013). *Machine Learning with R*, Packt Publishing.
8. Lesmeister, C. (2015). *Mastering Machine Learning with R*, Packt Publishing.
9. Johnson, R.A., Wichern, D.W. (2007). *Applied Multivariate Statistical Analysis*, 6th Edn., Pearson.
10. Anderson, T.W. (2003). *An Introduction to Multivariate Statistical Analysis*, 3rd Edn., Wiley.
11. Morrison, D.F. (2004). *Multivariate Statistical Methods*, 4th Edn., Duxbury Press.

List of Practicals

1. Linear and logistic regression with visualization
2. Model tuning with cross-validation in caret or sklearn
3. Classification using LDA and QDA on multivariate datasets
4. Clustering with silhouette analysis and PCA visualization
5. Recommender system using real-world e-commerce data
6. Case study: Predicting credit card default / heart disease classification
7. Final project: full pipeline from data preprocessing to final report & model deployment notebook (in RMarkdown/Jupyter)

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CO-PO mapping:

CO/PO	P01 (Critical Thinking)	P02 (Effective Communication)	P03 (Social Interaction)	P04 (Effective Citizenship)	P05 (Ethics)	P06 (Environment and Sustainability)	P07 (Self-directed and Life-long Learning)
C01	H	M					H
C02	H	M			L		H
C03	H	M			M		H
C04	H	H	M				H
C05	H	H	M				H
Avg	3.0	2.2	1.2	0.0	0.4	0.0	3.0

*** **H** means High relevance, **M** means medium relevance, **L** means Low relevance