BACHELOR OF SCIENCE

(HONORS) STATISTICS

Detailed Syllabus

Programme Code: STAB
Duration: 3 Years

EFFECTIVE FROM SESSION: 2019-2020

Department of Basic Sciences
Faculty of Science
CHHATRAPATI SHIVAJI MAHARAJ UNIVERSITY
PANVEL, NAVI MUMBAI

SEMESTER I

Course Type	Course Code	Course Name	L	T	P	IA	UE	Total Marks	Credits
DSC	STAB1010	Descriptive Statistics	4	0	0	30	70	100	4
DSC	MTHB1010	Algebra	5	1	0	30	70	100	6
GE	**	General Elective - I	4	0	0	30	70	100	4
AECC	ENGG1000	English Communication	2	0	0	15	35	50	2
DSC	STAB1011	Descriptive Statistics Lab	0	0	4	15	35	50	2
GE	**	General Elective - I Lab	0	0	4	15	35	50	2
		Total	**15**	**1**	**8**	**135**	**315**	**450**	**20**

Ability Enhancement Compulsory Courses (AECC)

Semester	Offering Department	Course Code	Course Name	(L-T-P)	Credits
I	English	ENGG1000	English Communication	2-0-0	2

STAB1010	DESCRIPTIVE STATISTICS	4L:0T:0P	4 CREDITS

Course objectives:

The objectives of this course are

1. To understand the four measurement scales
2. To interpret the utilization of mean values to describe group results
3. To apply measure of standard deviation in describing the properties of variability of group scores.
4. To calculate standard deviation values.
5. To calculate correlation and interpret results.

UNIT I

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

UNIT II

Measures of Central Tendency: mathematical and positional. Measures of Dispersion: range,quartile deviation, mean deviation, standard deviation, coefficient of variation, Moments,absolute moments, factorial moments, skewness and kurtosis, Sheppard's corrections.

UNIT III

Bivariate data: Definition, scatter diagram, simple, partial and multiple correlation(3 variables only), rank correlation. Simple linear regression, principle of least squares and fitting of polynomials and exponential curves.

UNIT IV

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

Text/Reference Books:

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

STAB1011	**DESCRIPTIVE STATISTICS LAB**	**0L:0T:4P**	**2 CREDITS**

List of Practical

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

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Analyse and compare different sets of data.
2. Classify the data by means of diagrams and graph.
3. Able to calculate and interpret the various measures of central tendency, dispersion skewness, Kurtosis & index numbers.
4. Understand the concept of correlation.

MTHB1010	**ALGEBRA**	**5L:1T:0P**	**6 Credits**

Course objectives:

The objectives of this course are

1. To understand the students concept of complex number.
2. To make student learn of set & functions.
3. To familiarize students with system of linear equations.
4. To impart the knowledge of linear transformation& eigen values,eigen vectors .

Unit I:Complex Number :

Polar representation of complex numbers, nth roots of unity, De Moivre's theorem for rational indices and its applications.

Unit II:Set & Functions:

Equivalence relations, Functions, Composition of functions, Invertible functions, One to onecorrespondence and cardinality of a set, Well-ordering property of positive integers, Divisionalgorithm, Divisibility and Euclidean algorithm, Congruence relation between integers,Principles of Mathematical Induction, statement of Fundamental Theorem of Arithmetic.

Unit III:Systems of linear equations:

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

Unit IV:Linear transformations:

Introduction to linear transformations, matrix of a linear transformation, inverse of a matrix,characterizations of invertible matrices. Subspaces of R^n, dimension of subspaces of R^n and rank of a matrix, Eigen values, Eigen Vectors and Characteristic Equation of a matrix.

Text /Reference Books:

1. Titu Andreescu and Dorin Andrica, Complex Numbers from A to Z, Birkhauser, 2006.
2. Edgar G. Goodaire and Michael M. Parmenter, Discrete Mathematics with Graph Theory, 3rd Ed., Pearson Education (Singapore) P. Ltd., Indian Reprint, 2005**.**
3. David C. Lay, Linear Algebra and its Applications,3rd Ed., Pearson Education Asia, Indian Reprint, 2007.

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Understand and apply the complex number in problems.
2. understand the concept of set & functions & how to solve the problems .
3. How to solve linear equations using matrix.
4. Understand the concept of linear transformations.

SEMESTER II

Course Type	**Course Code**	**Course Name**	L	T	P	IA	UE	Total Marks	Credits
DSC	STAB2010	Probability and Probability Distributions	4	0	0	30	70	100	4
DSC	MTHB2010	Differential Calculus & Vector Calculus	5	1	0	30	70	100	6
GE	**	Generic Elective - II	4	0	0	30	70	100	4
AECC	EVSG2000	Environmental Science	2	0	0	15	35	50	2
DSC	STAB2011	Probability and Probability Distributions Lab	0	0	4	15	35	50	2
GE	**	Generic Elective - II Lab	0	0	4	15	35	50	2
		Total	**15**	**1**	**8**	**135**	**315**	**450**	**20**

Ability Enhancement Compulsory Courses (AECC)

Semester	Offering Department	Course Code	Course Name	(L-T-P)	Credits
II	Basic Sciences	EVSG2000	Environmental Studies	2-0-0	2

STAB2010	PROBABILITYANDPROBABILITY DISTRIBUTIONS	4L:0T:0P	4 CREDITS

Course objectives:

The objectives of this course are

1. Students will use appropriate statistical terms to describe data.
2. Student will use appropriate statistical methods to collect, organize, display, and analyze relevant data.
3. Students will apply basic concepts of probability.
4. Students will apply concepts of various probability distributions to find probabilities.

UNIT I

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

UNIT II

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

UNIT III

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

UNIT IV

Standard probability distributions: Binomial, Poisson, geometric, negative binomial,hypergeometric, uniform, normal, exponential, Cauchy, beta and gamma along with their properties and limiting/approximation cases.

Text /Reference Books:

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

STAB2011	PROBABILITYAND PROBABILITY DISTRIBUTIONS LAB	0L:0T:4P	2 Credits

List of Practical

1. Fitting of binomial distributions for n and p = q = ½.
2. Fitting of binomial distributions for given n and p.
3. Fitting of binomial distributions after computing mean and variance.
4. Fitting of Poisson distributions for given value of lambda.
5. Fitting of Poisson distributions after computing mean.
6. Fitting of negative binomial.
7. Fitting of suitable distribution.
8. Application problems based on binomial distribution.
9. Application problems based on Poisson distribution.

10. Application problems based on negative binomial distribution.
11. Problems based on area property of normal distribution.
12. To find the ordinate for a given area for normal distribution.
13. Application based problems using normal distribution.
14. Fitting of normal distribution when parameters are given.
15. Fitting of normal distribution when parameters are not given.

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Understand the concept of probability.
2. Understand the concept of different types of random variables.
3. Understand the concept of Mathematical Expectation and Generating Functions
4. Understand the concept of Standard probability distributions.

MTHB2010	DIFFERENTIALCALCULUS&VECTOR CALCULUS	5L:1T:0P	6 CREDITS

Course learning objectives:

The objectives of this course are

1. To impart the knowledge of successive differentiation.
2. To make student learn series expansion & indeterminate forms.
3. To impart the knowledge of partial derivative.
4. To impart the knowledge of vector calculus.

Unit I:SUCCESSIVE DIFFERENTATION:

nth order derivative of standard functions :y=$(ax+b)^m$, y=e^{ax} ,y=a^{mx} ,y=$\frac{1}{(ax+b)}$,y=log(ax+b) ,y=sin(ax+b),y =cos(ax+b), y=$e^{ax}\sin(ax+b)$, y=$e^{ax}\cos(ax+b)$,Leibnitz's Theorem. Examples.

Unit II:SERIES EXPANSIONS AND INDETERMINATE FORMS:

Taylor's Theorem, Maclaurin's Theorem, Series expansions of some standard functions:e^x , sinx, cosx ,tanx ,$(1+x)^n$,log(1+x), Indeterminate forms :$\frac{0}{0}$,$\frac{\infty}{\infty}$,0.∞ , L'Hospitals Rule (Statement only).

Unit III:FUNCTIONS OF TWO VARIABLES:

Functions of two variables, Limit of a function of two variables, Continuity of a function of two variables ,Partial derivatives of first order, Partial derivatives of Higher order.Total derivative, Composite function , Implicit function. Homogeneous functions of two variables. Euler's Theorem on Homogeneous functions of two variables.

Unit IV:Vector calculus:

Triple product, introduction to vector functions, operations with vector-valued functions, limits and continuity of vector functions, differentiation and integration of vector functions, tangent and normal components of acceleration, modeling ballistics and planetary motion, Kepler's second law.

Text /Reference Books:

1. G.B. Thomas and R.L. Finney, Calculus, 9th Ed., Pearson Education, Delhi, 2005.
2. M.J. Strauss, G.L. Bradley and K. J. Smith, Calculus, 3rd Ed., Dorling Kindersley (India) P.Ltd. (Pearson Education), Delhi, 2007.

3. H. Anton, I. Bivens and S. Davis, Calculus, 7th Ed., John Wiley and Sons (Asia) P. Ltd.,Singapore, 2002.
4. R. Courant and F. John, Introduction to Calculus and Analysis(Volumes I & II), Springer-Verlag, New York, Inc., 1989.

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Understand the ideas of successive differentiation
2. Able to expand functions & finding the limits of indeterminate forms.
3. Able to find partial derivatives of different types of functions.
4. Perform vector calculus problems.

SEMESTER III

Course Type	**Course Code**	**Course Name**	L	T	P	IA	UE	Total Marks	Credits
DSC	STAB3010	Sampling Distributions	4	0	0	30	70	100	4
DSC	STAB3020	Survey Sampling & Indian Official Statistics	4	0	0	30	70	100	4
DSC	STAB3030	Mathematical Analysis	5	1	0	30	70	100	6
GE	**	Generic Elective - III	4	0	0	30	70	100	4
SEC	**	Skill Enhancement Course-I	2	0	0	15	35	50	2
		Practical							
DSC	STAB3011	Sampling Distributions	0	0	4	15	35	50	2
DSC	STAB3021	Survey Sampling & Indian Official Statistics	0	0	4	15	35	50	2
GE	**	Generic Elective - III	0	0	4	15	35	50	2
		Total	**19**	**1**	**12**	**135**	**315**	**500**	**26**

STAB3010	**SAMPLING DISTRIBUTIONS**	**4L:0T:0P**	**4 CREDITS**

Course objectives:

The objectives of this course are

1. Students will learn the concept of a sampling distribution.
2. Describe the distribution of the sample mean for samples obtained from normal populations.
3. Describe the distribution of the sample mean for samples obtained from a population that is not normal.
4. Students will learn the concept of different types of distributions.

UNIT I

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

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

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

UNIT IV
Exact sampling distributions: Student's and Fishers t-distribution, Derivation of its p.d.f.,nature of probability curve with different degrees of freedom, mean, variance, moments and limiting form of t distribution.Snedecore's F-distribution: Derivation of p.d.f., nature of p.d.f. curve with different degrees of freedom, mean, variance and mode. Distribution of 1/F(n1,n2). Relationship between t, Fand $\chi 2$ distributions. Test of significance and confidence Intervals based on t and F distributions.

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

STAB3011	**SAMPLING DISTRIBUTIONS LAB**	**0L:0T:4P**	**2 CREDITS**

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

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Understand the concept of sampling distribution.
2. Understand the concept of different types of error & level of significance.
3. Understand the concept of different types of distributions.
4. Understand the concept of large & small sample tests.

STBC3020	**SURVEY SAMPLING & INDIAN OFFICIAL STATISTICS**	**4L:0T:0P**	**4 CREDITS**

Course objectives:

The objectives of this course are

1. Students will learn the Concept of population and sample.
2. Student will the term estimation.
3. Students will learn ratio and regression methods of estimation.
4. Students will learn Present official statistical system in India.

UNIT I

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

UNIT II

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

UNIT III

Introduction to Ratio and regression methods of estimation, first approximation to the population mean and total (for SRS of large size), variances of these estimates and estimates of these variances, variances in terms of correlation coefficient for regression method of estimation and their comparison with SRS. Cluster sampling (equal clusters only) estimation of population mean and its variance, comparison (with and without randomly formed clusters). Relative efficiency of cluster sampling with SRS in terms of intra class correlation.Concept of sub sampling

UNIT IV

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

Text /Reference Books:

1. Cochran W.G. (1984):Sampling Techniques(3rd Ed.), Wiley Eastern.
2. Sukhatme,P.V., Sukhatme,B.V. Sukhatme,S. Asok,C.(1984). Sampling Theories of Survey With Application, IOWA State University Press and Indian Society of Agricultural Statistics
3. Murthy M.N. (1977): Sampling Theory & Statistical Methods, Statistical Pub. Society, Calcutta.
4. Des Raj and Chandhok P. (1998): Sample Survey Theory, Narosa Publishing House.
5. Goon A.M., Gupta M.K. and Dasgupta B. (2001): Fundamentals of Statistics (Vol.2), World Press.

6. Guide to current Indian Official Statistics, Central Statistical Office, GOI, New Delhi.
7. http://mospi.nic.in/

STAB3021	**SURVEY SAMPLING & INDIAN OFFICIAL STATISTICSLAB**	**0L:0T:4P**	**2 CREDITS**

List of Practical

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

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Understand the concept of population and sample.
2. Understand the concept of estimation.
3. Understand the concept of ratio and regression methods of estimation.
4. Understand the concept of Present official statistical system in India

STBC3030	**MATHEMATICAL ANALYSIS**	**5L:1T:0P**	**6 CREDITS**

Course objectives:

The objectives of this course are

1. Students will learn sequences & limits of sequences.
2. Student will learn Infinite series.
3. Students will learn Numerical Analysis.
4. Students will the concept of expansion of function.

UNIT-I

Real Analysis: Representation of real numbers as points on the line and the set of real numbers as complete ordered field. Bounded and unbounded sets, neighborhoods and limit points, Superimum and infimum, derived sets, open and closed sets, sequences and their convergence, limits of some special sequences such as and Cauchy's general principle of convergence, Cauchy's first theorem on limits, monotonic sequences,limit superior and limit inferior of a bounded sequence.

UNIT-II

Infinite series, positive termed series and their convergence, Comparison test, D'Alembert's ratio test, Cauchy's nth root test, Raabe's test. Gauss test, Cauchy's condensation test and integral test (Statements and Examples only). Absolute convergence of series, Leibnitz's test for the convergence of alternating series, Conditional convergence. Indeterminate form, L'Hospital's rule.

UNIT-III

Review of limit, continuity and differentiability, uniform Continuity and boundedness of a function. Rolle's and Lagrange's Mean Value theorems. Taylor's theorem with lagrange's and Cauchy's form of remainder(without proof). Taylor's and Maclaurin's series expansions of sinx, cosx, log (1+x).

UNIT-IV

Numerical Analysis: Factorial, finite differences and interpolation. Operators, E and divided difference. Newton's forward, backward and divided differences interpolation formulae.Lagrange's interpolation formulae. Central differences, Gauss and Stirling interpolation formulae. Numerical integration. Trapezoidal rule, Simpson's one-third rule, three-eights rule, Weddle's rule with error terms. Stirling's approximation to factorial n. Solution of difference equations of first order.

Text /Reference Books:

1. Malik S.C. and Savita Arora: Mathematical Analysis, Second Edition, Wiley EasternLimited, New AgeInternational Limited, New Delhi, 1994.
2. Somasundram D. and Chaudhary B.: A First Course in Mathematical Analysis,Narosa Publishing House, New Delhi, 1987.
3. Gupta S.L. and Nisha Rani: Principles of Real Analysis, Vikas Publ. House Pvt. Ltd.,New Delhi, 1995.

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Understand the concept of sequences & limits of sequences.
2. Understand the concept of convergence of infinite series.
3. Understand the concept of interpolation.
4. Understand the concept of Numerical integration.

SEMESTER IV

Course Type	**Course Code**	**Course Name**	L	T	P	IA	UE	Total Marks	Credits
DSC	STAB4010	Statistical Inference	4	0	0	30	70	100	4
DSC	STAB4020	Linear Models	4	0	0	30	70	100	4
DSC	STAB4030	Statistical Quality Control	4	0	0	30	70	100	4
GE	**	Generic Elective - IV	4	0	0	30	70	100	4
SEE	**	Skill Enhancement Course-II	2	0	0	15	35	50	2
DSC	STAB4011	Statistical Inference Lab	0	0	4	15	35	50	2
DSC	STAB4021	Linear Models Lab	0	0	4	15	35	50	2
DSC	STAB4031	Statistical Quality Control Lab	0	0	4	15	35	50	2
GE	**	Generic Elective - IV Lab	0	0	4	15	35	50	2
		Total	**18**	**0**	**16**	**195**	**455**	**650**	**26**

STAB4010	**STATISTICAL INFERENCE**	**4L:0T:0P**	**4 CREDITS**

Course objectives:

The objectives of this course are

1. To understand the students concept of unbiasedness.
2. To make student learn the concept of hypothesis.
3. To familiarize students with Sequential Analysis.

5. To impart the basic idea of Bayes estimators.

UNIT I

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

UNIT II

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

UNIT III

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

UNIT IV

Sequential Analysis: Sequential probability ratio test (SPRT) for simple vs simple hypotheses. Fundamental relations among α, β, A and B, determination of A and B in practice. Wald's fundamental identity and the derivation of operating characteristics (OC) and average sample number (ASN) functions, examples based on normal, Poisson, binomial and exponential distributions.

Text /Reference Books:

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

STAB4011	**STATISTICAL INFERENCE**	**0L:0T:4P**	**2 Credits**

List of Practical

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

17. SPRT procedure
18. OC function and OC curve
19. ASN function and ASN curve

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Understand the concept of unbiasednes.
2. Understand the concept of hypothesis.
3. Understand the concept of Sequential Analysis.
4. Understand the concept of Bayes estimators.

STAB4020	LINEAR MODELS	4L:0T:0P	4 CREDITS

Course objectives:

The objectives of this course are

1. To understand the students concept of Gauss-Markov set-up.
2. To make student learn the concept of Regression analysis.
3. To familiarize students with Analysis of variance.
4. To impart the basic idea of Model checking.

UNIT I

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

UNIT II

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

UNIT III

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

UNIT IV

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

Text /Reference Books:

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

STAB4021	LINEAR MODELS LAB	0L:0T:4P	2 CREDITS

List of Practical

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

12. Analysis of Covariance of a two way classified data

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Understand the concept of Gauss-Markov set-up.
2. Understand the concept of Regression analysis.
3. Understand the concept of Analysis of variance.
4. Understand the concept of Prediction from a fitted model.

STAB4030	STATISTICAL QUALITY CONTROL	4L:0T:0P	4 CREDITS

Course objectives:

The objectives of this course are

1. To understand the students concept of quality.
2. To make student learn the concept of different types of chart.
3. To familiarize students with sampling plan.
4. To impart the knowledge of Six-Sigma.

UNIT I

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

UNIT II

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

UNIT III

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

UNIT IV

Introduction to Six-Sigma: Overview of Six Sigma, Lean Manufacturing and Total QualityManagement (TQM). Organizational Structure and Six Sigma training plans- Selection Criteria for Six-Sigma roles and training plans. Voice of customers (VOC): Importance and VOC data collection. Critical to Quality(CTQ).Introduction to DMAIC using one case study:Define Phase, Measure Phase, Analyse Phase, Improve Phase and Control Phase.

Text /Reference Books:

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

STAB4031	STATISTICAL QUALITY CONTROL LAB	0L:0T:4P	2 CREDITS

List of Practical

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

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Understand the concept of quality.
2. Understand the concept of different types of chart.
3. Understand the concept of sampling plan.
4. Understand the concept of Six-Sigma.

SEMESTER V

Course Type	**Course Code**	**Course Name**	L	T	P	IA	UE	Total Marks	Credits
DSC	STAB5010	Stochastic Processes and Queuing Theory	4	0	0	30	70	100	4
DSC	STAB5020	Statistical Computing Using C/C++ Programming	4	0	0	30	70	100	4
DSE	**	Discipline Specific Elective-I	4	0	0	30	70	100	4
DSE	**	Discipline Specific Elective-II	4	0	0	30	70	100	4
DSC	STAB5011	Stochastic Processes and Queuing Theory Lab	0	0	4	15	35	50	2
DSC	STAB5021	Statistical Computing Using C/C++ Programming Lab	0	0	4	15	35	50	2
DSE	**	Discipline Specific Elective-I Lab	0	0	4	15	35	50	2
DSE	**	Discipline Specific Elective-II Lab	0	0	4	15	35	50	2
		Total	**16**	**00**	**16**	**180**	**420**	**600**	**24**

STBC5010	**STOCHASTIC PROCESSES AND QUEUING THEORY**	**4L:0T:0P**	**4 CREDITS**

Course objectives:

The objectives of this course are

1. Students will learn the probability distribution.
2. Student will learn Markov Chains.
3. Students will apply basic concepts of Poisson Process .
4. Students will learn the concept of queuing model .

UNIT I

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

UNIT II

Markov Chains: Definition of Markov Chain, transition probability matrix, order of Markov chain, Markov chain as graphs, higher transition probabilities. Generalization of independent Bernoulli trials, classification of states and chains, stability of Markov system, graph theoretic approach.

UNIT III

Poisson Process: postulates of Poisson process, properties of Poisson process, inter-arrival time, pure birth process, Yule Furry process, birth and death process, pure death process.

UNIT IV

Queuing System: General concept, steady state distribution, queuing model, M/M/1 with finite and infinite system capacity, waiting time distribution (without proof). Gambler's Ruin Problem: Classical ruin problem, expected duration of the game.

Text /Reference Books:

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

STAB5011	**STOCHASTIC PROCESSES AND QUEUING THEORYLAB**	**0L:0T:4P**	**2 CREDITS**

List of Practical

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

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Understand the concept of probability distribution.
2. Understand the concept of Markov Chains.
3. Understand the concept of Poisson Process.
4. Understand the concept of queuing model.

STBC5020	**STATISTICAL COMPUTING USING C/C++ PROGRAMMING**	**4L:0T:0P**	**4 CREDITS**

Course objectives:
The objectives of this course are

1. Students will learn the History and importance of C/C++..
2. Student will learn different types of loop in C/C++:.
3. Students will learn different types of functions in programming.
4. Students will learn the concept of pointer.

UNIT I
History and importance of C/C++. Components, basic structure programming, character set, C/C++ tokens, Keywords and Identifiers and execution of a C/C++ program. Data types:Basic data types, Enumerated data types, derived data types. Constants and variables:declaration and assignment of variables, Symbolic Constants, overflow and underflow of data.Operators and Expressions: Arithmetic, relational, logical, assignment, increment/decrement,operators, precedence of operators in arithmetic, relational and logical expression. Implicit and explicit type conversions in expressions, library functions. Managing input and output
operations: reading and printing formatted and unformatted data

UNIT II
Decision making and branching - if…else, nesting of if…else, else if ladder, switch,conditional (?) operator. Looping in C/C++: for, nested for, while, do…while, jumps in and out of loops.Arrays: Declaration and initialization of one-dim and two-dim arrays. Character arrays and strings: Declaring and initializing string variables, reading and writing strings from Terminal (using scanf and printf only).

UNIT III
User- defined functions: A multi-function program using user-defined functions, definition of functions, return values and their types, function prototypes and calls. Category of Functions :no arguments and no return values, arguments but no return values , arguments with return values, no arguments but returns a value, functions that return multiple values. Recursion function. Passing arrays to functions, Storage class of Variables.

UNIT IV
Pointers: Declaration and initialization of pointer variables, accessing the address of avariable, accessing a variable through its pointer, pointer expressions, pointer increments/decrement and scale factor. Pointers and arrays, arrays of pointers, pointers as function arguments, functions returning pointers Structure: Definition and declaring, initialization, accessing structure members, copying andcomparison of structure variables, array of structures, structure pointers. Dynamic memory allocation functions :malloc, calloc and free.Pre processors: Macro substitution, macro with argument File inclusion in C/C++: Defining and opening a file (only r, w and a modes), closing a file,I/O operations on files-fscanf and fprintf functions.

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

STAB5021	**STATISTICAL COMPUTING USING**	**0L:0T:4P**	**2 CREDITS**

	C/C++ PROGRAMMING LAB		

(Using C/C++ Programming Language)

List of Practical

1. Plot of a graph y = f(x)
2. Roots of a quadratic equation (with imaginary roots also)
3. Sorting of an array and hence finding median
4. Mean, Median and Mode of a Grouped Frequency Data
5. Variance and coefficient of variation of a Grouped Frequency Data
6. Preparing a frequency table
7. Value of n! using recursion
8. Random number generation from uniform, exponential, normal(using CLT) and gamma distribution, calculate sample mean and variance and compare with population parameters.
9. Matrix addition, subtraction, multiplication Transpose and Trace
10. Fitting of Binomial, Poisson distribution and apply Chi-square test for goodness of fit
11. Chi-square contingency table
12. t-test for difference of means
13. Paired t-test
14. F-ratio test
15. Multiple and Partial correlation.
16. Compute ranks and then calculate rank correlation(without tied ranks)
17. Fitting of lines of regression

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Understand the concept of C/C++:.
2. Understand the concept of different types of loop in C/C++:..
3. Understand the concept ofdifferent types of functions in programming.
4. Understand the concept of pointer.

SEMESTER VI

Course Type	**Course Code**	**Course Name**	L	T	P	IA	UE	Total Marks	Credits
DSC	STAB6010	Design of Experiments	4	0	0	30	70	100	4
DSC	STAB6020	Multivariate Analysis and Nonparametric Methods	4	0	0	30	70	100	4
DSE	**	Discipline Specific Elective-III	4	0	0	30	70	100	4
DSE	**	Discipline Specific Elective-IV	4	0	0	30	70	100	4
DSC	STAB6011	Design of Experiments Lab	0	0	4	15	35	50	2
DSC	STAB6021	Multivariate Analysis and Nonparametric Methods	0	0	4	15	35	50	2
DSE	**	Discipline Specific Elective-III Lab	0	0	4	15	35	50	2
DSE	**	Discipline Specific Elective-IV Lab	0	0	4	15	35	50	2
		Total	16	00	16	180	420	600	24

STAB6010	DESIGN OF EXPERIMENTS	4L:0T:0P	4 CREDITS

Course objectives:

The objectives of this course are

1. Students will learn the concept of Experimental designs.
2. Student will learn Block Designs .
3. Students will learn concepts of Factorial experiments.
4. Students will learn concepts of Fractional factorial experiments.

UNIT I

Experimental designs: Role, historical perspective, terminology, experimental error, basic principles, uniformity trials, fertility contour maps, choice of size and shape of plots and blocks.Basic designs: Completely Randomized Design (CRD), Randomized Block Design (RBD),Latin Square Design (LSD) – layout, model and statistical analysis, relative efficiency,analysis with missing observations.

UNIT II

Incomplete Block Designs: Balanced Incomplete Block Design (BIBD) – parameters,relationships among its parameters, incidence matrix and its properties, Symmetric BIBD,Resolvable BIBD, Affine Resolvable BIBD, Intra Block analysis, complimentary BIBD,Residual BIBD, Dual BIBD, Derived BIBD.

UNIT III

Factorial experiments: advantages, notations and concepts, 22, 23…2n and 32 factorialexperiments, design and analysis, Total and Partial confounding for 2n ($n \leq 5$), 32 and 33.Factorial experiments in a single replicate.

UNIT IV

Fractional factorial experiments: Construction of one-half and one-quarter fractions of 2n ($n \leq 5$) factorial experiments, Alias structure, Resolution of a design.

Text /Reference Books:

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

STAB6011	DESIGN OF EXPERIMENTS LAB	0L:0T:4P	2 CREDITS

List of Practical

1. Analysis of a CRD
2. Analysis of an RBD
3. Analysis of an LSD
4. Analysis of an RBD with one missing observation
5. Analysis of an LSD with one missing observation
6. Intra Block analysis of a BIBD
7. Analysis of 22 and23 factorial in CRD and RBD
8. Analysis of 22 and23 factorial in LSD
9. Analysis of a completely confounded two level factorial design in 2 blocks
10. Analysis of a completely confounded two level factorial design in 4 blocks
11. Analysis of a partially confounded two level factorial design
12. Analysis of a single replicate of a 2n design
13. Analysis of a fraction of 2n factorial design

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Understand the concept of Experimental designs.
2. Understand the concept of Block Designs .
3. Understand the concept of Factorial experiments.
4. Understand the concept of Fractional factorial experiments.

STAB6020	**MULTIVARIATE ANALYSIS AND NONPARAMETRIC METHODS**	**4L:0T:0P**	**4 CREDITS**

Course objectives:

The objectives of this course are

1. To impart the knowledge of Bivariate Normal Distribution.
2. To make student learn Multivariate Normal distribution.
3. To impart the knowledge of Applications of Multivariate Analysis.
4. To impart the knowledge of Nonparametric Tests.

UNIT I

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

UNIT II

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

UNIT III

Applications of Multivariate Analysis: Discriminant Analysis, Principal Components Analysis and Factor Analysis.

UNIT IV

Nonparametric Tests: Introduction and Concept, Test for randomness based on total number of runs, Empirical distribution function, Kolmogrov Smirnov test for one sample, Sign tests- one sample and two samples, Wilcoxon-Mann-Whitney test, Kruskal-Wallis test.

Text /Reference Books:

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

STAB6021	**MULTIVARIATE ANALYSIS AND NONPARAMETRIC METHODS LAB**	**0L:0T:4P**	**2 CREDITS**

List of Practical

1. Multiple Correlation
2. Partial Correlation

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

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Understand the concept of Bivariate Normal Distribution.
2. Understand the concept of Multivariate Normal distribution.
3. Understand the concept of Applications of Multivariate Analysis.
4. Understand the concept of Nonparametric Tests.

Ability Enhancement Compulsory Course (AECC)

ENGG1000	**ENGLISH COMMUNICATION**	**2L:0T:0P**	**2 CREDITS**

Course Objectives.

1. To acquaint the students with appropriate language skills with the purpose of improving the existing ones – LSRW.
2. To make the learners understand the importance and effective use of non-verbal communication.
3. To make the learner proficient in public speaking and presentation skills.
4. To guide and teach the students to utilize the principles of professional business and technical writing for effective communication in the global world.
5. To deploy technology to communicate effectively in various situations.

Unit I :

Communication and Communication Process:

Introduction to Communication, Forms and functions of Communication, Barriers to Communication ((linguistic and semantic, psychological, physical, mechanical, cultural), and overcoming them, Types of communication: verbal and non-verbal communication.

Reading: Introduction to Reading, Barriers to Reading, Types of Reading: Skimming, Scanning, Fast Reading, Strategies for Reading, Comprehension.

Listening : Importance of Listening, Types of Listening, Barriers to Listening.

Unit II :

Writing Skills, Reading Skills & Listening Skills: Features of Good Language, Technical Style of writing, Writing Emails and it's etiquettes, Technical Reports: Report Writing: Types, Format and Structure of reports.

Unit III :

Letter Writing: Types of letters: Job application letter, complaint letter, enquiry letter, reply to enquiry, sales letter. Essential and non-essential parts of letters, formats of letters.

Unit IV :

Grammar: Types of sentences, Antonyms and Synonyms, Use of Auxiliaries and Modal Auxiliaries, Synonyms and Antonyms, Pairs of confused words, Common Errors in sentences.

Unit V :

Soft Skills: Body language, Team work and skills, Decision making ability, Negotiation skills and Interview skills.

Unit VI :

Dialogues Writing and Speaking: Greeting someone and responding to greet, Thanking someone and responding to thanks, Making inquiry and responding to enquiry on telephone, Making request and responding to request.

References:

1. Communication in Organizations by Dalmar Fisher, Jaico Publishing House
2. Communication Skills by Meenakshi Raman & Sangeeta Sharma, Oxford University Press.
3. Business Correspondence & Report-writing by R.C. Sharma& Krishna Mohan, Tata McGraw-Hill Education.
4. Effective Technical Communication by Ashraf Rizvi, Tata McGraw-Hill.
5. Technical Writing & Professional Communication for non-native speakers of English by Thomas N. Huckin & Leslie A. Olsen, McGraw –Hill.
6. Mastering Communication by Nicky Stanton, Palgrave Master Series
7. www.buisnesscommunicationskills.com
8. www.kcitraing.com
9. www.mindtools.com
10. Journal of Business Communication.

Course Outcomes.

The students will be able to-

1. Understand and evaluate information they listen to and express their ideas with greater clarity.
2. Speak and respond effectively along the various channels of communication in a business organization.
3. Speak convincingly before an audience with the help of an expanded vocabulary and enhanced digital content.
4. Communicate through result oriented writing both within and outside the organization.
5. Write a set of effective and easy to understand technical description, instructions.

EVSG2000	**ENVIRONMENT STUDIES**	**2L:0T:0P**	**2 CREDITS**

Course Objectives:

1. To consider how the natural and built environments shape and are shaped by multiple socio-cultural and political factors.
2. To think across and beyond existing disciplinary boundaries, mindful of the diverse forms of knowledge and experience that arise from human interactions with the world around them.

Course Outcome :

The Environmental Studies major prepares students for careers as leaders in understanding and addressing complex environmental issues from a problem-oriented, interdisciplinary perspective. Students:

1. Master core concepts and methods from ecological and physical sciences and their application in environmental problem solving.
2. Master core concepts and methods from economic, political, and social analysis as they pertain to the design and evaluation of environmental policies and institutions.
3. Appreciate the ethical, cross-cultural, and historical context of environmental issues and the links between human and natural systems.
4. Understand the transnational character of environmental problems and ways of addressing them, including interactions across local to global scales.
5. Apply systems concepts and methodologies to analyze and understand interactions between social and environmental processes.
6. Reflect critically about their roles and identities as citizens, consumers and environmental actors in a complex, interconnected world.
7. Demonstrate proficiency in quantitative methods, qualitative analysis, critical thinking, and written and oral communication needed to conduct high-level work as interdisciplinary scholars and/or practitioners.

Unit I: Introduction to environmental studies : L;2

Multidisciplinary nature of environmentalstudies; Scope and importance; Concept of sustainability and sustainabledevelopment.

UnitII:EcosystemsL:8Ecosystem, Structure and function of ecosystem; Energy flow in an ecosystem:food chains, food webs and ecological succession. Case studies of the following ecosystems: Forestecosystem, Grasslandecosystem, Desertecosystem, Aquatic ecosystems (ponds, streams, lakes, rivers, oceans,estuaries)

Unit III : Natural Resources : Renewable andNon-renewable Resources L:8

Land resources and landuse change; Land degradation, soil erosion anddesertification.
Deforestation: Causes and impacts due to mining, dam building on environment, forests, biodiversity and tribalpopulations. Water : Use and over-exploitation of surface and ground water,floods, droughts, conflicts overwater(international & inter-state).Energy resources : Renewable and non renewable energy sources, use of alternate energy sources, growing energy needs, casestudies.

Unit IV : Biodiversity and ConservationL:8

Levels of biological diversity : genetic, species and ecosystem diversity; Biogeographic zones of India; Biodiversity patterns and global biodiversity hotspotsIndia asa mega-biodiversity nation; Endangered and endemic speciesof India.Threatsto biodiversity :Habitat loss, poaching of wildlife, man-wildlife conflicts, biological invasions, Conservation of biodiversity : In-situ and Ex-situ conservation of biodiversity.
Ecosystem and biodiversity services: Ecological, economic, social, ethical, aesthetic and Informational value.

UnitV : Environmental Pollution L:8

5.1 Environmental pollution : types, causes, effects and controls; Air, water, soil and noise pollution
5.2 Nuclear hazards and human healthrisks
5.3 Solid waste management : Control measures of urban and industrialwaste.
5.4 Pollution casestudies.

Unit VI : Environmental Policies & Practices L:8

Climate change, global warming, ozone layer depletion, acid rain and impacts on human communities andagriculture**,** Environment Laws **,** Environment Protection Act; Air (Prevention & Control of Pollution) Act; Water (Prevention and control of Pollution) Act; Wildlife Protection Act; Forest Conservation Act.

International agreements: Montreal and Kyoto protocols and Convention on Biological Diversity (CBD)., Nature reserves, tribal populations and rights, and human wildlife conflicts in Indian context.

Unit VII : Human Communities and the Environment L:6

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

Unit VIII : Field Work L:6

Visit to an area to document environmental assets: river/ forest/ flora/fauna, etc.Visit to a local polluted site---Urban/Rural/Industrial/Agricultural.Study of common plants, insects, birds and basic principles of identification. Study of simple ecosystems---pond, river, Delhi Ridge, etc

References:

1. Gadgil, M., & Guha, R. 1993. This Fissured Land: An Ecological History of India. Univ. of California Press.
2. Gleeson, B. and Low, N. (eds.) 1999. Global Ethics and Environment, London, Routledge.
3. Gleick, P. H. 1993. Water in Crisis. Pacific Institute for Studies in Dev., Environment & Security. Stockholm Env. Institute, Oxford Univ. Press.
4. Groom, Martha J., Gary K. Meffe, and Carl Ronald Carroll. Principles of Conservation Biology. Sunderland: Sinauer Associates, 2006.
5. Grumbine, R. Edward, and Pandit, M.K. 2013. Threats from India's Himalaya dams. Science, 339: 36-37.
6. McCully, P. 1996. Rivers no more: the environmental effects of dams (pp. 29---64). Zed Books.
7. McNeill, John R. 2000. Something New Under the Sun: An Environmental History of the Twentieth Century.
8. Odum, E.P., Odum, H.T. & Andrews, J. 1971. Fundamentals of Ecology. Philadelphia: Saunders.
9. Pepper, I.L., Gerba, C.P. & Brusseau, M.L. 2011. Environmental and Pollution Science. Academic Press.
10. Rao, M.N. & Datta, A.K. 1987. Waste Water Treatment. Oxford and IBH Publishing Co. Pvt. Ltd.
11. Raven, P.H., Hassenzahl, D.M. & Berg, L.R. 2012. Environment. 8th edition. John Wiley & Sons.
12. Rosencranz, A., Divan, S., & Noble, M. L. 2001. Environmental law and policy in India. Tripathi 1992.
13. Sengupta, R. 2003. Ecology and economics: An approach to sustainable development. OUP.
14. Singh, J.S., Singh, S.P. and Gupta, S.R. 2014. Ecology, Environmental Science and Conservation. S. Chand Publishing, New Delhi.
15. Sodhi, N.S., Gibson, L. & Raven, P.H. (eds). 2013. Conservation Biology: Voices from the Tropics. John Wiley & Sons.
16. Thapar, V. 1998. Land of the Tiger: A Natural History of the Indian Subcontinent.
17. Warren, C. E. 1971. Biology and Water Pollution Control. WB Saunders.
18. Wilson, E. O. 2006. The Creation: An appeal to save life on earth. New York: Norton.

World Commission on Environment and Development. 1987. Our Common Future. Oxford University Press.

LIST OF GENERAL ELECTIVE SUBJECTS

List of Generic Electives Available for students of B.Sc. (Hons.)

Semester	Offering Department	Course Code (T+P)	Course Name	(L-T-P)	Credits
I	Physics	PHYB1010+ PHYB1011	Mechanics	4-0-4	6
II	Physics	PHYB2010+ PHYB2011	Thermal Physics	4-0-4	6

III	Physics	PHYB3010+ PHYB3011	Waves and Optics	4-0-4	6
IV	Physics	PHYB4010+ PHYB4011	Elements of Modern Physics	4-0-4	6
I	Chemistry	CHYB1010 + CHYB1011	Inorganic Chemistry	4-0-4	6
II	Chemistry	CHYB2010 + CHYB2011	Organic Chemistry	4-0-4	6
III	Chemistry	CHYB1020 + CHYB1021	Physical Chemistry	4-0-4	6
IV	Chemistry	CHYB2020 + CHYB2021	Basic Analytical Chemistry	4-0-4	6

---------- **PHYSICS** ----------

PHYB1010	**MECHANICS**	**4L:0T:0P**	**4 CREDITS**

Course learning objectives:

The objectives of this course are

1. To impart the knowledge of dynamical laws of motion.
2. To impart the knowledge of rotational dynamics, eleasiticity and fluid motion.
3. To make students learn the theory of gravitation and central forces.
4. To make students learn oscillatory motion and non inertial systems.
5. To impart the knowledge of special theory of relativity.

Unit 1: **Fundamentals of Dynamics:** L:13

Reference frames. Inertial frames; Review of Newton's Laws of Motion. Galilean transformations; Galilean invariance. Momentum of variable- mass system: motion of rocket. Motion of a projectile in Uniform gravitational field Dynamics of a system of particles. Centre of Mass. Principle of conservation of momentum. Impulse. Work and Kinetic Energy Theorem. Conservative and non-conservative forces. Potential Energy. Energy diagram. Stable and unstable equilibrium. Elastic potential energy. Force as gradient of potential energy. Work & Potential energy. Work done by non-conservative forces. Law of conservation of Energy. Elastic and inelastic collisions between particles. Centre of Mass and Laboratory frames.

Unit 2: **Rotational Dynamics, Elasticity and Fluid Motion: L: 17**

Angular momentum of a particle and system of particles. Torque. Principle of conservation of angular momentum. Rotation about a fixed axis. Moment of Inertia. Calculation of moment of inertia for rectangular, cylindrical and spherical bodies. Kinetic energy of rotation. Motion involving both translation and rotation. Relation between Elastic constants. Twisting torque on a Cylinder or Wire. Kinematics of Moving Fluids: Poiseuille's Equation for Flow of a Liquid through a Capillary Tube.

Unit 3: **Gravitation and Central Force Motion:** L:16

Law of gravitation. Gravitational potential energy. Inertial and gravitational mass. Potential and field due to spherical shell and solid sphere.

Motion of a particle under a central force field. Two-body problem and its reduction to one-body problem and its solution. The energy equation and energy diagram. Kepler's Laws. Satellite in circular orbit and applications. Geosynchronous orbits. Weightlessness. Basic idea of global positioning system (GPS). Simple Harmonic Oscillations. Differential equation of SHM and its solution. Kinetic energy, potential energy, total energy and their time-average values. Damped

oscillation. Forced oscillations: Transient and steady states; Resonance, sharpness of resonance; power dissipation and Quality Factor.

Unit 4: **Non-Inertial Systems:** L: 4

Non-inertial frames and fictitious forces. Uniformly rotating frame. Laws of Physics in rotating coordinate systems. Centrifugal force. Coriolis force and its applications. Components of Velocity and Acceleration in Cylindrical and Spherical Coordinate Systems.

Unit 5: **Special Theory of Relativity:** L:10

Michelson-Morley Experiment and its outcome. Postulates of Special Theory of Relativity. Lorentz Transformations. Simultaneity and order of events. Lorentz contraction. Time dilation. Relativistic transformation of velocity, frequency and wave number. Relativistic addition of velocities. Variation of mass with velocity. Massless Particles. Mass-energy Equivalence. Relativistic Doppler effect. Relativistic Kinematics. Transformation of Energy and Momentum.

Text /Reference Books:

1. An introduction to mechanics, D. Kleppner, R.J. Kolenkow, 1973, McGraw-Hill.
2. Mechanics, Berkeley Physics, vol.1, C.Kittel, W.Knight, et.al. 2007, Tata McGraw-Hill.
3. Physics, Resnick, Halliday and Walker 8/e. 2008, Wiley.
4. Analytical Mechanics, G.R. Fowles and G.L. Cassiday. 2005, Cengage Learning.
5. Feynman Lectures, Vol. I, R.P.Feynman, R.B.Leighton, M.Sands, 2008, Pearson Education
6. Introduction to Special Relativity, R. Resnick, 2005, John Wiley and Sons.
7. University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
8. Mechanics, D.S. Mathur, S. Chand and Company Limited, 2000
9. University Physics. F.W Sears, M.W Zemansky, H.D Young 13/e, 1986, Addison Wesley
10. Physics for scientists and Engineers with Modern Phys., J.W. Jewett, R.A. Serway, 2010, Cengage Learning
11. Theoretical Mechanics, M.R. Spiegel, 2006, Tata McGraw Hill.

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Understand concept of centre of mass and different kinds of frames of references.
2. Acquire knowledge of different types of forces of work and energy.
3. Understand the rotational and translational dimensions.
4. Understand the dynamics of oscillations and non inertial systems.
5. Impart the knowledge about theory of relativity and its importance.

PHYB1011	MECHANICS LAB	0L:0T:4P	2 CREDITS

LIST OF EXPERIMENTS:

1. Measurements of length (or diameter) using vernier calipers, screw gauge and travelling microscope.
2. To study the random error in observations.
3. To determine the elastic Constants of a wire by Searle's method.
4. To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method).
5. To determine the Moment of Inertia of a Flywheel.
6. To determine the value of g using Bar Pendulum.
7. To determine the value of g using Kater's Pendulum.
8. To study the Motion of Spring and calculate (a) Spring constant, (b) **g** and (c) Modulus of rigidity.
9. To determine the Modulus of Rigidity of a Wire by Maxwell's needle.
10. To determine **g** and velocity for a freely falling body using Digital Timing Technique.
11. To determine the Young's Modulus of a Wire by Optical Lever Method.

PHYB2010	THERMAL PHYSICS	4L:0T:0P	4 CREDITS

Course learning objectives:

The objectives of this course are

1. Impart the knowledge of the basic laws of thermodynamics
2. To make students learn the concept of entropy and free energies.
3. To impart the knowledge of thermodynamic relations and kinetic theroy of gases.
4. To impart the knowledge of heat through molecular collisions.
5. To convey the basic concepts related to behavior of real gasses.

Unit 1: **Introduction to Thermodynamics:** L:10

Zeroth and First Law of Thermodynamics: Extensive and intensive Thermodynamic Variables, Thermodynamic Equilibrium, Zeroth Law of Thermodynamics & Concept of Temperature, Concept of Work & Heat, State Functions, First Law of Thermodynamics and its differential form, Internal Energy, First Law & various processes, Applications of First Law: General Relation between CP and CV, Work Done during Isothermal and Adiabatic Processes, Compressibility and Expansion Co-efficient.

Unit 2: **Second Law of Thermodynamics:** L:8

Reversible and Irreversible process with examples. Conversion of Work into Heat and Heat into Work. Heat Engines. Carnot's Cycle, Carnot engine & efficiency. Refrigerator & coefficient of performance, 2nd Law of Thermodynamics: Kelvin-Planck and Clausius Statements and their Equivalence. Carnot's Theorem. Applications of Second Law of Thermodynamics: Thermodynamic Scale of Temperature and its Equivalence to Perfect Gas Scale.

Unit 3: **Entropy and Thermodynamic Potentials:** L:14

Concept of Entropy, Clausius Theorem. Clausius Inequality, Second Law of Thermodynamics in terms of Entropy. Entropy of a perfect gas. Principle of Increase of Entropy. Entropy Changes in Reversible and Irreversible processes with examples. Entropy of the Universe. Entropy Changes in Reversible and Irreversible Processes. Principle of Increase of Entropy. Temperature–Entropy diagrams for Carnot's Cycle. Third Law of Thermodynamics. Unattainability of Absolute Zero. Thermodynamic Potentials: Internal Energy, Enthalpy, Helmholtz Free Energy, Gibb's Free Energy. Their Definitions, Properties and Applications. Surface Films and Variation of Surface Tension with Temperature. Magnetic Work, Cooling due to adiabatic demagnetization, First and second order Phase Transitions with examples, Clausius Clapeyron Equation and Ehrenfest equations.

Unit 4: **Maxwell's Thermodynamic Relations:** L:10

Derivations and applications of Maxwell's Relations, Maxwell's Relations:(1) Clausius Clapeyron equation, (2) Values of Cp-Cv, (3) TdS Equations, (4) Joule-Kelvin coefficient for Ideal and Van der Waal Gases, (5) Energy equations, (6) Change of Temperature during Adiabatic Process.

Unit 5**: Kinetic Theory of Gases:** L:20

Maxwell-Boltzmann Law of Distribution of Velocities in an Ideal Gas and its Experimental Verification. Mean, RMS and Most Probable Speeds. Degrees of Freedom. Law of Equipartition of Energy (No proof required). Specific heats of Gases. Mean Free Path. Collision Probability. Estimates of Mean Free Path. Transport phenomenon in Ideal Gases. Brownian Motion and its Significance. Behavior of Real Gases: Deviations from the Ideal Gas Equation. The Virial Equation. Boyle Temperature. Van der Waal's Equation of State for Real Gases. Values of Critical Constants. Law of Corresponding States. Comparison with Experimental Curves. P-V Diagrams. Free Adiabatic Expansion of a Perfect Gas. Joule- Thomson Effect.

Text /Reference Books:

1. Heat and Thermodynamics, M.W. Zemansky, Richard Dittman, 1981, McGraw-Hill.
2. A Treatise on Heat, Meghnad Saha, and B.N.Srivastava, 1958, Indian Press
3. Thermal Physics, S. Garg, R. Bansal and Ghosh, 2nd Edition, 1993, Tata McGraw-Hill
4. Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer.
5. Thermodynamics, Kinetic Theory & Statistical Thermodynamics, Sears & Salinger. 1988, Narosa.
6. Concepts in Thermal Physics, S.J. Blundell and K.M. Blundell, 2nd Ed., 2012, Oxford University Press
7. Thermal Physics, A. Kumar and S.P. Taneja, 2014, R. Chand Publications.

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Understand different laws of thermodynamics.
2. Understand basic concepts of entropy and enthalpy.
3. Understand the concept of free energies and thermodynamics potential.
4. Understand the kinetic Theory of Gases.
5. Possess sound knowledge of theories for ideal and real gases.

PHYB2011	THERMAL PHYSICS LAB	0L:0T:4P	4 CREDITS

LIST OF EXPERIMENTS:

1. To study the variation of Thermo-Emf of a Thermocouple with Difference of Temperature of its Two Junctions.
2. Newtons law of cooling.
3. Stefan's constant.
4. To determine Mechanical Equivalent of Heat, J, by Callender and Barne's constant flow method.
5. To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee and Charlton's disc method.
6. To determine the Temperature Coefficient of Resistance by Platinum Resistance Thermometer (PRT).
7. To calibrate a thermocouple to measure temperature in a specified Range using Null Method

PHYB3010	WAVES AND OPTICS	4L:0T:0P	4 CREDITS

Course learning objectives:

The objectives of this course are

1. To impart the knowledge of collinear harmonic oscillator and wave motion.
2. To make students learn about superposition of harmonic waves
3. To make students learn the theories of interference and various interferometers.
4. To impart the knowledge of diffraction and diffractometers.
5. To impart the knowledge of holography.

Unit 1: **Superposition of Harmonic oscillations:** L:9

Linearity and Superposition Principle. Superposition of two collinear oscillations having (1) equal frequencies and (2) different frequencies (Beats). Superposition of N collinear Harmonic Oscillations

with (1) equal phase differences and (2) equal frequency differences. Graphical and Analytical Methods. Lissajous Figures with equal an unequal frequency and their uses.

Unit 2: **Wave Motion:** L:8

Plane and Spherical Waves. Longitudinal and Transverse Waves. Plane Progressive (Travelling) Waves. Wave Equation. Particle and Wave Velocities. Differential Equation. Pressure of a Longitudinal Wave. Energy Transport. Intensity of Wave. Water Waves: Ripple and Gravity Waves. Velocity of Transverse Vibrations of Stretched Strings. Velocity of Longitudinal Waves in a Fluid in a Pipe. Newton's Formula for Velocity of Sound. Laplace's Correction.

Unit 3: **Superposition of Two Harmonic Waves:** L:10

Standing (Stationary) Waves in a String: Fixed and Free Ends. Analytical Treatment. Phase and Group Velocities. Changes with respect to Position and Time. Energy of Vibrating String. Transfer of Energy. Normal Modes of Stretched Strings. Plucked and Struck Strings. Melde's Experiment. Longitudinal Standing Waves and Normal Modes. Open and Closed Pipes. Superposition of N Harmonic Waves. Electromagnetic nature of light. Definition and properties of wave front. Huygens Principle. Temporal and Spatial Coherence.

Unit 4: **Interference:** L:13

Division of amplitude and wavefront. Young's double slit experiment. Lloyd's Mirror and Fresnel's Biprism. Phase change on reflection: Stokes' treatment. Interference in Thin Films: parallel and wedge-shaped films. Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes). Newton's Rings: Measurement of wavelength and refractive index. Michelson Interferometer- (1) Idea of form of fringes (No theory required), (2) Determination of Wavelength, (3) Wavelength Difference, (4) Refractive Index, and (5) Visibility of Fringes. Fabry-Perot interferometer.

Unit 5: **Diffraction:** L:20

Kirchhoff's Integral Theorem, Fresnel-Kirchhoff's Integral formula. (Qualitative discussion only) Fraunhofer diffraction: Single slit. Circular aperture, Resolving Power of a telescope. Double slit. Multiple slits. Diffraction grating. Resolving power of grating. Fresnel Diffraction: Fresnel's Assumptions. Fresnel's Half-Period Zones for Plane Wave. Explanation of Rectilinear Propagation of Light. Theory of a Zone Plate: Multiple Foci of a Zone Plate. Fresnel's Integral, Fresnel diffraction pattern of a straight edge, a slit and a wire. Principle of Holography. Recording and Reconstruction Method. Theory of Holography as Interference between two Plane Waves. Point source holograms.

Text /Reference Books:

1. Waves: Berkeley Physics Course, vol. 3, Francis Crawford, 2007, Tata McGraw-Hill.
2. Fundamentals of Optics, F.A. Jenkins and H.E. White, 1981, McGraw-Hill
3. Principles of Optics, Max Born and Emil Wolf, 7th Edn., 1999, Pergamon Press.
4. Optics, Ajoy Ghatak, 2008, Tata McGraw Hill
5. The Physics of Vibrations and Waves, H. J. Pain, 2013, John Wiley and Sons.
6. The Physics of Waves and Oscillations, N.K. Bajaj, 1998, Tata McGraw Hill.
7. Fundamental of Optics, A. Kumar, H.R. Gulati and D.R. Khanna, 2011, R. Chand Publications.

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Understand wave motion and theories of superposition of harmonic oscillations.
2. Understand superposition of harmonic waves and wave optics.
3. Understand theories of interference.
4. Possess sound knowledge of diffraction methods.
5. Understand principle of holography.

PHYB3011	WAVES AND OPTICS LAB	0L:0T:4P	2 CREDITS

LIST OF EXPERIMENTS:

1. Familiarization with: Schuster`s focusing; determination of angle of prism.
2. To determine refractive index of the Material of a prism using sodium source.
3. To determine the dispersive power and Cauchy constants of the material of a prism using mercury source.
4. To determine the wavelength of sodium source using Michelson's interferometer.
5. To determine wavelength of sodium light using Fresnel Biprism.
6. To determine wavelength of sodium light using Newton's Rings.
7. To determine wavelength of (1) Na source and (2) spectral lines of Hg source using plane diffraction grating.
8. To determine dispersive power and resolving power of a plane diffractiongrating.
9. To study Lissajous Figures.
10. To determine the frequency of an electric tuning fork by Melde's experiment and verify λ^2 –T law.

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Take measurements using various optical benches, interferometers, diffractometers.
2. Determine angle, refrective index and dispersive power of a prism using various techniques.
3. Determine wavelength of a light source using various optical techniques.
4. Determine dispersive power and resolving power of diffraction gratings.
5. Study and understand lissajous figures.

PHYB4010	ELEMENTS OF MODERN PHYSICS	4L:0T:0P	4 CREDITS

Course learning objectives:

The objectives of this course are

1. To impart the knowledge of quantum theory of radiation
2. To impart the knowledge of basic quantum mechanics
3. To make student learn elements of nuclear physics
4. To impart the knowledge on lasers and their applications

Unit 1: **Quantum theory of Radiation:** L:14

Planck's quantum law, Planck's constant and light as a collection of photons; Blackbody, Quantum theory of Light; Photo-electric effect and Compton scattering. De Broglie wavelength and matter waves;

Davisson-Germer experiment. Wave description of particles by wave packets. Group and Phase velocities and relation between them. Two-Slit experiment with electrons. Probability. Wave amplitude and wave functions. Position measurement- gamma ray microscope thought experiment; Wave-particle duality,

Unit 2: **Quantum Mechanics:** L:19

Heisenberg uncertainty principle (Uncertainty relations involving Canonical pair of variables): Derivation from Wave Packets, impossibility of a particle following a trajectory; Estimating minimum energy of a confined particle using uncertainty principle; Energy-time uncertainty principle- application to virtual particles and range of an interaction. Two slit interference experiment with photons, atoms and particles; linear superposition principle as a consequence; Matter waves and wave amplitude; Schrodinger equation for non-relativistic particles; Momentum and Energy operators; stationary states; physical interpretation of a wave function, probabilities and normalization; Probability and probability current densities in one dimension. One dimensional infinitely rigid box- energy eigenvalues and eigenfunctions, normalization; Quantum dot as example; Quantum mechanical scattering and tunneling in one dimension-across a step potential & rectangular potential barrier.

Unit 3: **Nuclear Physics:** L:12

Size and structure of atomic nucleus and its relation with atomic weight; Impossibility of an electron being in the nucleus as a consequence of the uncertainty principle. Nature of nuclear force, NZ graph, Liquid Drop model: semi-empirical mass formula and binding energy, Nuclear Shell Model and magic numbers. Radioactivity**:** stability of the nucleus; Law of radioactive decay; Mean life and half-life; Alpha decay; Beta decay- energy released, spectrum and Pauli's prediction of neutrino; Gamma ray emission, energy-momentum conservation: electron-positron pair creation by gamma photons in the vicinity of a nucleus.

Unit 4: **Fission and fusion:** L:8

Mass deficit, relativity and generation of energy; Fission - nature of fragments and emission of neutrons. Nuclear reactor: slow neutrons interacting with Uranium 235; Fusion and thermonuclear reactions driving stellar energy (brief qualitative discussions).

Unit 5: **Lasers:** L:8

Einstein’s A and B coefficients. Metastable states. Spontaneous and Stimulated emissions. Optical Pumping and Population Inversion. Three-Level and Four-Level Lasers. Ruby Laser and He-Ne Laser. Basic lasing.

Text /Reference Books:

1. Concepts of Modern Physics, Arthur Beiser, 2002, McGraw-Hill.
2. Introduction to Modern Physics, Rich Meyer, Kennard, Coop, 2002, Tata McGraw Hill
3. Introduction to Quantum Mechanics, David J. Griffith, 2005, Pearson Education.
4. Physics for scientists and Engineers with Modern Physics, Jewett and Serway, 2010, Cengage Learning.
5. Modern Physics, G.Kaur and G.R. Pickrell, 2014, McGraw Hill
6. Quantum Mechanics: Theory & Applications, A.K.Ghatak & S.Lokanathan, 2004, Macmillan
7. Modern Physics, J.R. Taylor, C.D. Zafiratos, M.A. Dubson, 2004, PHI Learning.

8. Theory and Problems of Modern Physics, Schaum`s outline, R. Gautreau and W. Savin, 2nd Edn, Tata McGraw-Hill Publishing Co. Ltd.
9. Quantum Physics, Berkeley Physics, Vol.4. E.H.Wichman, 1971, Tata McGraw-Hill Co.
10. Basic ideas and concepts in Nuclear Physics, K.Heyde, 3rd Edn., Institute of Physics Pub.
11. Six Ideas that Shaped Physics: Particle Behave like Waves, T.A.Moore, 2003, McGraw Hill

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Understand quantum theory of radiation
2. Possess knowledge of introductory quantum mechanics
3. Understand the fundamentals of nuclear physics.
4. Understand the working principle and applications of lasers.

PHYB4011	**ELEMENTS OF MODERN PHYSICS LAB**	**0L:0T:4P**	**2 CREDITS**

LIST OF EXPERIMENTS:

1. To determine the wavelength of laser source using diffraction of single slit.
2. To determine the wavelength of laser source using diffraction of double slits.
3. To determine (1) wavelength and (2) angular spread of He-Ne laser using plane diffraction grating
4. Measurement of Planck's constant using black body radiation and photo-detector.
5. Photo-electric effect: photo current versus intensity and wavelength of light; maximum energy of photo-electrons versus frequency of light
6. To determine work function of material of filament of directly heated vacuum diode.
7. To determine the Planck's constant using LEDs of at least 4 different colours.
8. To determine the wavelength of H-alpha emission line of Hydrogen atom.
9. To determine the ionization potential of mercury.
10. To determine the absorption lines in the rotational spectrum of Iodine vapour.
11. To determine the value of e/m by (a) Magnetic focusing or (b) Bar magnet.
12. To setup the Millikan oil drop apparatus and determine the charge of an electron.

To show the tunneling effect in tunnel diode using I-V characteristics.

----------CHEMISTRY----------

CHYB1010	**INORGANIC CHEMISTRY**	**4L:0T:0P**	**4 CREDITS**

Course Learning Objectives:

The objective of this course is:

1. To make student learn about wave mechanics.
2. To study about periodic properties of S,P,D & F block elements
3. To impart knowledge of covalent and ionic bond.

4. To impart knowledge of metallic bonds and weak Chemical Forces
5. To make student learn about oxidation and reduction.

Unit 1: **Atomic Structure:** L:14

Bohr's theory, its limitations and atomic spectrum of hydrogen atom. Wave mechanics: de Broglie equation, Heisenberg's Uncertainty Principle and its significance, Schrödinger's wave equation, significance of ψ and ψ^2. Quantum numbers and their significance. Normalized and orthogonal wave functions. Sign of wave functions. Radial and angular wave functions for hydrogen atom. Radial and angular distribution curves. Shapes of *s, p, d* and *f* orbitals. Contour boundary and probability diagrams. Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau's principle and its limitations, Variation of orbital energy with atomic number.

Unit 2: **Periodicity of Elements:** L:16
s, p, d, f block elements, the long form of periodic table. Properties of the elements with reference to *s*&*p*-block. (a) Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table. (b) Atomic radii (van der Waals) Ionic and crystal radii. Covalent radii (octahedral and tetrahedral) Ionization enthalpy, Successive ionization enthalpies and factors affecting ionization energy. Applications of ionization enthalpy. Electron gain enthalpy, trends of electron gain enthalpy. Electronegativity, Pauling's/ Mulliken's/Allred Rachow's/ and Mulliken-Jaffé's electronegativity scales. Variation of electronegativity with bond order, partial charge, hybridization, group electronegativity. Sanderson's electron density ratio.

Unit 3: **Chemical Bonding I:** L:16
lonic bond: General characteristics, types of ions, size effects, radius ratio rule and its limitations. Packing of ions in crystals. Born-Landé equation with derivation and importance of Kapustinskii expression for lattice energy. Madelung constant, Born-Haber cycle and its application, Solvation energy.

Covalent bond: Lewis structure, Valence Bond theory (Heitler-London approach). Energetics of hybridization, equivalent and non-equivalent hybrid orbitals. Bent's rule, Resonance and resonance energy, Molecular orbital theory. Molecular orbital diagrams of diatomic and simple polyatomic molecules N_2, O_2, C_2, B_2, F_2, CO, NO, and their ions; HCl, BeF_2, CO_2, (idea of s-p mixing and orbital interaction to be given). Formal charge, Valence shell electron pair repulsion theory (VSEPR), shapes of simple molecules and ions containing lone pairs and bond pairs of electrons, multiple bonding (σ and π bond approach) and bond lengths. Covalent character in ionic compounds, polarizing power and polarizability. Fajan's rules and consequences of polarization. Ionic character in covalent compounds: Bondmomentanddipolemoment.

Unit 4: **Chemical Bonding II:** L:10
Metallic Bond: Qualitative idea of valence bond and band theories. Semiconductors and insulators, defects in solids.
Weak Chemical Forces: van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interactions, Instantaneous dipole-induced dipole interactions. Repulsive forces, Hydrogen bonding (theories of hydrogen bonding, valence bond treatment) Effects of chemical force, melting and boiling points, solubility energetics of dissolution process.

Unit 5:**Oxidation-Reduction:** L:4
Redox equations, Standard Electrode Potential and its application to inorganic reactions.

Text/Reference Books:

- Lee, J.D. Concise Inorganic Chemistry, ELBS, 1991.
- Douglas, B.E. and Mc Daniel, D.H., Concepts & Models of Inorganic Chemistry, Oxford, 1970

- Atkins, P.W. & Paula, J. Physical Chemistry, Oxford Press, 2006.
- Day, M.C. and Selbin, J. Theoretical Inorganic Chemistry, ACS Publications 1962.

Course Outcomes:

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

1. Understand the concept of wave mechanics.
2. Know the variations of periodic properties in S, P, D and F block elements.
3. Have knowledge of different types of bond nature.
4. Understand the weak chemical forces interactions.
5. To solve problems related to oxidation and reduction.

CHYB1011	**INORGANIC CHEMISTRY LAB**	**0L:0T:4P**	**2 CREDITS**

LIST OF EXPERIMENTS:

(A) Titrimetric Analysis

(i) Calibration and use of apparatus
(ii) Preparation of solutions of different Molarity/Normality of titrants

(B) Acid-Base Titrations

(i) Estimation of carbonate and hydroxide present together in mixture.
(ii) Estimation of carbonate and bicarbonate present together in a mixture.
(iii) Estimation of free alkali present in different soaps/detergents

(C) Oxidation-Reduction Titrimetry

(i) Estimation of Fe(II) and oxalic acid using standardized $KMnO_4$ solution.
(ii) Estimation of oxalic acid and sodium oxalate in a given mixture.
(iii) Estimation of Fe(II) with $K_2Cr_2O_7$ using internal (diphenylamine, anthranilic acid) and external indicator.

Reference text:

1. Vogel, A.I. A Textbook of Quantitative Inorganic Analysis, ELBS.

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. To have knowledge of calibration of different glassware's.
2. To prepare different normal and molar solution.
3. To have knowledge of acid base reaction.
4. To Estimate free alkali present in different soaps/detergents.
5. Understand concept of oxidation and reduction based reactions.

CHYB2010	**ORGANIC CHEMISTRY**	**4L:0T:0P**	**4 CREDITS**

Course Learning Objectives:

The objective of this course is:

1. To impart knowledge of hybridization, Electronic Displacements reactions.
2. To make students learn about chemistry of alkanes.
3. To make students understand carbon-carbon pi bonds.
4. To impart knowledge of cycloalkanes and conformational Analysis.
5. To make students understand aromatic character of cyclic compounds.

Unit 1: **Organic Compounds:** L: 16

Classification, and Nomenclature, Hybridization, Shapes of molecules, Influence of hybridization on bond properties.

Electronic Displacements: Inductive, electromeric, resonance and mesomeric effects, hyperconjugation and their applications; Dipole moment; Organic acids and bases; their relative strength. Homolytic and Heterolytic fission with suitable examples. Curly arrow rules, formal charges; Electrophiles and Nucleophiles; Nucleophlicity and basicity; Types, shape and their relative stability of Carbocation's, Carbanion, Free radicals and Carbenes.

Introduction to types of organic reactions and their mechanism: Addition, Elimination and Substitution reactions.

Unit 2: **Carbon-Carbon sigma bonds::** L: 8

Chemistry of alkanes: Formation of alkanes, Wurtz Reaction, Wurtz-Fittig Reactions, Free radical substitutions: Halogenation -relative reactivity and selectivity.

Unit 3: **Carbon-Carbon pi bonds::** L: 14

Formation of alkenes and alkynes by elimination reactions, Mechanism of E1, E2, E1cb reactions. Saytzeff and Hofmann eliminations.

Reactions of alkenes: Electrophilic additions their mechanisms (Markownikoff/ Anti Markownikoff addition), mechanism of oxymercuration-demercuration, hydroborationoxidation, ozonolysis, reduction (catalytic and chemical), syn and anti-hydroxylation (oxidation). 1,2-and 1,4-addition reactions in conjugated dienes and, Diels-Alder reaction; Allylic and benzylicbromination and mechanism, e.g. propene, 1-butene, toluene, ethyl benzene.

Reactions of alkynes: Acidity, Electrophilic and Nucleophilic additions. Hydration to form carbonyl compounds, Alkylation of terminal alkynes.

Unit 4: **Cycloalkanes and Conformational Analysis** : L: 10

Types of cycloalkanes and their relative stability, Baeyer strain theory, Conformation analysis of alkanes: Relative stability: Energy diagrams of cyclohexane: Chair, Boat and Twist boat forms; Relative stability with energy diagrams.

Unit 5: **Aromaticity:** L: 12

Hückel's rule, aromatic character of arenes, cyclic carbocations/carbanions and heterocyclic compounds with suitable examples. Electrophilic aromatic substitution: halogenation, nitration, sulphonation and Friedel-Craft's alkylation/acylation with their mechanism. Directing effects of the groups.

Text/Reference Books:

- Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Eliel, E. L. &Wilen, S. H. Stereochemistry of Organic Compounds; Wiley: London, 1994.

- Kalsi, P. S. Stereochemistry Conformation and Mechanism; New Age International, 2005.

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Apply the knowledge of hybridization and molecular displacements in molecular modeling.
2. Learn the preparation and properties of alkanes.
3. Have knowledge of chemical reactions of alkenes and alkynes.
4. Understand the concept of Conformation analysis of alkanes.
5. Understand concept of aromaticity.

CHYB2011	**ORGANIC CHEMISTRY LAB**	**0L:0T:4P**	**2 CREDITS**

LIST OF EXPERIMENTS:

1. Checking the calibration of the thermometer

2. Purification of organic compounds by crystallization using the following solvents:

a. Water
b. Alcohol
c. Alcohol-Water

3. Determination of the melting points of above compounds and unknown organic compounds (Kjeldahl method and electrically heated melting point apparatus)

4. Effect of impurities on the melting point – mixed melting point of two unknown organic compounds
5. Determination of boiling point of liquid compounds. (boiling point lower than and more than 100 °C by distillation and capillary method)

6. Chromatography

a. Separation of a mixture of two amino acids by ascending and horizontal paper chromatography
b. Separation of a mixture of two sugars by ascending paper chromatography
c. Separation of a mixture of o-and p-nitrophenol or o-and p-aminophenol by thin layer chromatography (TLC)

Reference Books

- Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)
- Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson (2012)

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. To purify organic compounds by crystallization.
2. To determine the melting points of unknown organic compounds.
3. To determine mixed melting point of two unknown organic compounds
4. To determine boiling point of liquid compounds.
5. Separate a mixture of various compounds by the help of chromatography.

CHYB1020	PHYSICAL CHEMISTRY	4L:0T:0P	4 CREDITS

Course Learning Objectives:

The objective of this course is:

1. To impart knowledge of phase and binary solutions.
2. Students will learn about molecularity, rate laws and kinetics of complex reactions.
3. To gain knowledge of collision theory of reaction rates and temperature dependence of reaction rates.
4. To impart knowledge of enzyme catalysis.
5. To make students learn about surface chemistry.

Unit 1: **Phase Equilibria:** L:28

Concept of phases, components and degrees of freedom, liquid-vapour and solid-vapour equilibria, phase diagram for one component systems, two and three component systems.

Binary solutions: Gibbs-Duhem-Margules equation, its derivation and applications to fractional distillation of binary miscible liquids (ideal and nonideal), azeotropes, lever rule, partial miscibility of liquids, CST, miscible pairs, steam distillation. Nernst distribution law: its derivation and applications.

Unit 2: **Chemical Kinetics I:** L:10

Order and molecularity of a reaction, rate laws in terms of the advancement of a reaction, differential and integrated form of rate expressions up to second order reactions, experimental methods of the determination of rate laws, kinetics of complex reactions (integrated rate expressions up to first order only): (i) Opposing reactions (ii) parallel reactions and (iii) consecutive reactions and their differential rate equations (steady-state approximation in reaction mechanisms) (iv) chain reactions.

Unit 3: **Chemical Kinetics II:** L:8

Temperature dependence of reaction rates; Arrhenius equation; activation energy. Collision theory of reaction rates, Lindemann mechanism, qualitative treatment of the theory of absolute reaction rates.

Unit 4: **Catalysis:**L:8

Types of catalyst, specificity and selectivity, mechanisms of catalyzed reactions at solid surfaces; effect of particle size and efficiency of nanoparticles as catalysts. Enzyme catalysis, Michaelis-Menten mechanism, acid-base catalysis.

Unit 5: **Surface chemistry:**L:6

Physical adsorption, chemisorption, adsorption isotherms. nature of adsorbed state.

Text/Reference Books:

- Peter Atkins & Julio De Paula, Physical Chemistry9th Ed., Oxford University Press (2010).
- Castellan, G. W. Physical Chemistry, 4th Ed., Narosa (2004).
- McQuarrie, D. A. & Simon, J. D., Molecular Thermodynamics, Viva Books Pvt. Ltd.: New Delhi (2004).
- Engel, T. & Reid, P. Physical Chemistry 3rd Ed., Prentice-Hall (2012).
- Assael, M. J.; Goodwin, A. R. H.; Stamatoudis, M.; Wakeham, W. A. & Will, S. Commonly Asked Questions in Thermodynamics. CRC Press: NY (2011).

- Zundhal, S.S. Chemistry concepts and applicationsCengage India (2011).
- Ball, D. W. Physical ChemistryCengage India (2012).
- Mortimer, R. G. Physical Chemistry3rd Ed., Elsevier: NOIDA, UP (2009).
- Levine, I. N. Physical Chemistry6th Ed., Tata McGraw-Hill (2011).
- Metz, C. R. Physical Chemistry2nd Ed., Tata McGraw-Hill (2009).

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Students will learn about phase equilibria and binary solutions.
2. Will have idea of molecularity and rate laws.
3. Students will have idea about collision theory of reaction rates.
4. Students will understand about enzyme catalytic reaction.
5. Solve problems related to surface chemistry

CHYB1021	PHYSICAL CHEMISTRY LAB	0L:0T:4P	2 CREDITS

LISTOF EXPERIMENTS:

I. Determination of critical solution temperature and composition of the PHBEnol-water system and to study the effect of impurities on it.
II. Phase equilibria: Construction of the phase diagram using cooling curves or ignition tube method:
a. simple eutectic and
b. congruently melting systems.
III. Distribution of acetic/ benzoic acid between water and cyclohexane.
IV. Study the equilibrium of at least one of the following reactions by the distribution method:

(i) $I_2(aq) + I^- \rightarrow I_3^{2+}(aq)$

(ii) $Cu2+(aq) + n NH3 \rightarrow Cu(NH3)n$

V. Study the kinetics of the following reactions.
1.Initial rate method: Iodide-persulphatereaction
2.Integrated rate method:

a. Acid hydrolysis of methyl acetate with hydrochloric acid.
b. Saponification of ethyl acetate. Compare the strengths of HCl and H_2SO_4 by studying kinetics of hydrolysis of methyl acetate.
VI. Adsorption
Verify the Freundlich and Langmuir isotherms for adsorption of acetic acid on activated charcoal.

Text/Reference Books:

- Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).
- Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry8th Ed.; McGraw-Hill: New York (2003).
- Halpern, A. M. &McBane, G. C. Experimental Physical Chemistry3rd Ed.; W.H. Freeman & Co.: New York (2003).

CHYB2020	BASICANALYTICALCHEMISTRY	4L:0T:0P	4 CREDITS

Course Learning Objectives:

The objective of this course is:

1. To introduce students about analytical chemistry and its concept.
2. To impart knowledge of analysis of soil and water.
3. To make students study about food products and preservatives.
4. To make students learn about chromatography and constituents of cosmetics.
5. To study the use spectrophotometer and flame photometer for performing different experiments.

Unit 1: **Introduction:** L: 5

Introduction to Analytical Chemistry and its interdisciplinary nature. Concept of sampling. Importance of accuracy, precision and sources of error in analytical measurements. Presentation of experimental data and results, from the point of view of significant figures.

Unit 2: **Analysis of soil and water:** L: 7 Composition of soil, Concept of pH and pH measurement, Complexometric titrations, Chelation, Chelating agents, use of indicators

Determination of pH of soil samples. Estimation of Calcium and Magnesium ions as Calcium carbonate by Complexometric titration. Analysis of water: Definition of pure water, sources responsible for contaminating water, water sampling methods, water purification methods.Determination of pH, acidity and alkalinity of a water sample. Determination of dissolved oxygen (DO) of a water sample.

Unit 3: **Analysis of food products**: L:6

Nutritional value of foods, idea about food processing and food preservations and adulteration.

Identification of adulterants in some common food items like coffee powder, asafoetida, chilli powder, turmeric powder, coriander powder and pulses, etc.

Unit 4: **Analysis of preservatives and colouring matter:** L: 6

Ion-exchange: Column, ion-exchange chromatography etc. Determination of ion exchange capacity of anion / cation exchange resin (using batch procedure if use of column is not feasible). Analysis of cosmetics: Major and minor constituents and their function. Analysis of deodorants and antiperspirants, Al, Zn, boric acid, chloride, sulphate. Determination of constituents of talcum powder: Magnesium oxide, Calcium oxide, Zinc oxide and Calcium carbonate by Complexometric titration.

Unit 5: **Suggested Applications(Any one):** L:6

To study the use of PHBEnolphthalein in trap cases.

To analyze arson accelerants.

To carry out analysis of gasoline.

Suggested Instrumental demonstrations:

Estimation of macro nutrients: Potassium, Calcium, Magnesium in soil samples by flame photometry.

Spectrophotometric determination of Iron in Vitamin / Dietary Tablets.

Spectrophotometric Identification and Determination of Caffeine and Benzoic Acid in Soft Drink.

Text/ Reference Books:

1. Willard, H. H. Instrumental Methods of Analysis, CBS Publishers.
2. Skoog &Lerry. Instrumental Methods of Analysis, Saunders College Publications, New York.
3. Skoog, D.A.; West, D.M. & Holler, F.J. Fundamentals of Analytical Chemistry 6th Ed., Saunders College Publishing, Fort Worth (1992).
4. Harris, D. C. Quantitative Chemical Analysis, W. H. Freeman.
5. Dean, J. A. Analytical Chemistry Notebook, McGraw Hill.
6. Day, R. A. & Underwood, A. L. Quantitative Analysis, Prentice Hall of India.
7. Freifelder, D. Physical Biochemistry 2nd Ed., W.H. Freeman and Co., N.Y. USA (1982).

8. Cooper, T.G. The Tools of Biochemistry, John Wiley and Sons, N.Y. USA. 16 (1977).
9. Vogel, A. I. Vogel's Qualitative Inorganic Analysis 7th Ed., Prentice Hall.
10. Vogel, A. I. Vogel's Quantitative Chemical Analysis6th Ed., Prentice Hall.
11. Robinson, J.W. Undergraduate Instrumental Analysis 5th Ed., Marcel Dekker, Inc., New York (1995).

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. To develop the knowledge of analytical chemistry.
2. To analyse composition and concepts of soil and water.
3. To understand some food products and identification of some common food items.
4. To develop the knowledge of ion exchange chromatography.
5. Handle flame photometer and spectrophotometer.

CHYB2021	BASICANALYTICALCHEMISTRY LAB	0L:0T:4P	2 CREDITS

LIST OF EXPERIMENTS:

1. Determination of pH of soil samples.
2. Estimation of Calcium and Magnesium ions as Calcium carbonate by Complexometric titration.
3. Determination of pH, acidity and alkalinity of a water sample.
4. Determination of dissolved oxygen (DO) of a water sample.
5. Identification of adulterants in some common food items like coffee powder, asafoetida, chilli powder, turmeric powder, coriander powder and pulses, etc.
6. Estimation of macro nutrients: Potassium, Calcium, Magnesium in soil samples by flame photometry.
7. Spectrophotometric determination of Iron in Vitamin / Dietary Tablets.
8. Spectrophotometric Identification and Determination of Caffeine and Benzoic Acid in Soft Drink

List of Generic Electives offered by Department for students in B.Sc. Statistics(Hons.) in Allied Programmes (Chemistry, Physics, Geology, Psychology etc.)

Semester	Course Code (T+P)	Course Name	(L-T-P)	Credits
I	STAB1010	Descriptive Statistics	4-0-4	6
II	STAB2010	Probability and Probability Distributions	4-0-4	6
III	STAB3010	Sampling Distributions	4-0-4	6
IV	STAB4010	Statistical Inference	4-0-4	6

Skill Enhancement Compulsory Course(SEC)

Semester	Course Code	Course Name	(L-T-P)	Credits
III	CSEG3210	Computer graphics	2-0-0	2

III	STAB3211	Statistical-Data Analysis Using Software Packages	0-0-2	2
III	STAB3221	Statistical Data Analysis Using R	0-0-2	2
IV	CSEG4210	Operating System: Linux	2-0-0	2
IV	STAB4211	Statistical Techniques for Research Methods	0-0-2	2
IV	STAB4221	Data Base Management Systems	0-0-2	2

CSEG3210	COMPUTER GRAPHICS	2L:0T:0P	2 CREDITS

Course Objective:

1. To introduce the use of the components of a graphics system and become familiar with building approach of graphics system components and algorithms related with them
2. To be able to discuss the application of computer graphics concepts in the development of computer games, information visualization, and business applications.

UNIT I

Development of computer Graphics: Raster Scan and Random Scan graphics storages, displaysprocessors and character generators, colour display techniques, interactive input/output devices.

UNIT II

Points, lines and curves: Scan conversion, line-drawing algorithms, circle and ellipse generation,conic-section generation,

UNIT III

Polygon: filling anti aliasing. Two-dimensional viewing: Coordinatesystems, linear transformations, line and polygon clipping algorithms.

Reference Books:

1. D. Hearn and M.P. Baker, Computer Graphics, 2nd Ed., Prentice–Hall of India, 2004.
2. J.D. Foley, A van Dam, S.K. Feiner and J.F. Hughes, Computer Graphics: Principals andPractices, 2nd Ed., Addison-Wesley, MA, 1990.
3. D.F. Rogers, Procedural Elements in Computer Graphics, 2nd Ed., McGraw Hill BookCompany, 2001.
4. D.F. Rogers and A.J. Admas, Mathematical Elements in Computer Graphics, 2nd Ed., McGraw Hill Book Company,

Course Outcomes: Learner will be able to…

1. To list the basic concepts used in computer graphics.
2. To implement various algorithms to scan, convert the basic geometrical primitives, transformations, Area filling, clipping.
3. To understand a typical graphics pipeline.

STAB3211	STATISTICAL-DATA ANALYSIS	0L:0T:2P	2 CREDITS

	USING SOFTWARE PACKAGES		

Course Objective:
This course will review and expand upon core topics in statistics and probability, particularly by initiating the beneficiaries of the course to at least one of the software packages viz., SPSS, Minitab, Matlab, for statistical computing.

UNIT I
Learn how to load data, plot a graph viz. histograms (equal class intervals and unequal classintervals), box plot, stem-leaf, frequency polygon, pie chart, ogives with graphical summaries of data

UNIT II
Generate automated reports giving detailed descriptive statistics, correlation and lines of regression.

UNIT III
Random number generation and sampling procedures. Fitting of polynomials and exponential curves. Application Problems based on fitting of suitable distribution, Normal probability plot.

UNIT IV
Simple analysis and create and manage statistical analysis projects, import data, code editing,Basics of statistical inference in order to understand hypothesis testing and compute p-values and confidence intervals.

Reference Books:

1. 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
3. Cho, M,J., Martinez, W.L. (2014) Statistics in MATLAB: A Primer, Chapman and Hall/CRC

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Will learn how to load data .
2. Will be able to represent data graphically.
3. Will be able to do data analysis using softwares like SPSS, Minitab, Matlab.

STAB3221	**STATISTICAL DATA ANALYSIS USING R**	**0L:0T:2P**	**2 CREDITS**

Course Objective:
This course will review and expand upon core topics in probability and statistics through the study and practice of data analysis and graphical interpretation using `R'.

UNIT I
Learn how to load data, plot a graph viz. histograms (equal class intervals and unequal class intervals), box plot, stem-leaf, frequency polygon, pie chart, ogives with graphical summaries of data

UNIT II
Generate automated reports giving detailed descriptive statistics, correlation and lines of regression.

UNIT III
Random number generation and sampling procedures. Fitting of polynomials and exponential curves. Application Problems based on fitting of suitable distribution, Normal probability plot.

UNIT IV
Simple analysis and create and manage statistical analysis projects, import data, code editing, Basics of statistical inference in order to understand hypothesis testing and compute p-values and confidence intervals.

Reference Books:

1. Gardener, M (2012) Beginning R: The Statistical Programming Language, Wiley Publications.

2. Braun W J, Murdoch D J (2007): A First Course in Statistical Programming with R. Cambridge University Press. New York

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Understand the concept of graphical interpretation using `R'.
2. Understand the concept of data analysis using `R'.
3. Understand the concept of correlation and lines of regression.

CSEG4210	OPERATING SYSTEM: LINUX	2L:0T:0P	2 CREDITS

Course Objective:

1. To make students understand the features of Linux operating system
2. To make students learn the components of Linux
3. To learn basic Linux commands and printing Linux documents

UNIT I

Linux : The Operating System: Linux history, Linux features, Linux distributions, Linux'srelationship to Unix,

UNIT II

Overview of Linux architecture: Installation, Start up scripts, systemprocesses (an overview), Linux Security, The Ext2 and Ext3 File systems: General
Characteristics of, The Ext3 File system,

UNIT III

File permissions. User Management: Types of users,the powers of Root, managing users (adding and deleting): using the command line and GUItools.

UNIT IV

Resource Management in Linux: file and directory management, system calls for files ProcessManagement, Signals, IPC: Pipes, FIFOs, System V IPC, Message Queues, system calls forprocesses, Memory Management, library and system calls for memory.

Reference Books:

1. Arnold Robbins, Linux Programming by Examples The Fundamentals, 2nd Ed., Pearson Education, 2008.
2. Cox K, Red Hat **Linux Administrator's Guide**, PHI, 2009.
3. R. Stevens, UNIX Network Programming, 3rd Ed., PHI, 2008.
4. Sumitabha Das, Unix Concepts and Applications, 4th Ed., TMH, 2009.
5. Ellen Siever, Stephen Figgins, Robert Love, Arnold Robbins, Linux in a Nutshell, 6th Ed.,O'Reilly Media, 2009.
6. Neil Matthew, Richard Stones, Alan Cox, Beginning Linux Programming, 3rd Ed.,

Course Outcomes: Learner will be able to…

1. Identify the basic Unix general purpose commands.
2. Apply basic of administrative task.
3. Apply networking Unix commands.
4.

STAB4211	**STATISTICAL TECHNIQUES FOR RESEARCH METHODS**	**0L:0T:2P**	**2 CREDITS**

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

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

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

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

UNIT IV
Develop a questionnaire, collect survey data pertaining to a research problem (such as gender discriminations in private v/s government sector, unemployment rates, removal of subsidy,impact on service class v/s unorganized sectors), interpret the results and draw inferences.

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

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Understand the concept of research.
2. Understand the concept ofdata collection.
3. Understand the concept of data analysis and interpretation.

STAB4221	**DATA BASE MANAGEMENT SYSTEMS**	**0L:0T:2P**	**2 CREDITS**

Course Objective:
This skill based course is structured to enhance database handling, data manipulation and data processing skills through SQL. The course will enable its beneficiaries develop data centric computer applications.

UNIT I
Introduction: Overview of Database Management System, Introduction to Database Languages, advantages of DBMS over file processing systems.

UNIT II
Relational Database Management System: The Relational Model, Introduction to SQL: Basic Data Types, Working with relations of RDBMS: Creating relations e.g. Bank, College Database (create table statement)

UNIT III
Modifying relations (alter table statement), Integrity constraints over the relation like Primary Key , Foreign key, NOT NULL to the tables, advantages and disadvantages of relational Database System

UNIT IV

Database Structure: Introduction, Levels of abstraction in DBMS, View of data, Role of Database users and administrators, Database Structure: DDL, DML, Data Manager (Database Control System).Types of Data Models Hierarchical databases, Network databases, Relational databases, Object oriented databases

Reference Books:

1. Gruber, M(1990): Understanding SQL, BPB publication
2. Silberschatz, A, Korth, H and Sudarshan,S(2011) "Database System and Concepts",6th Edition McGraw-Hill.
3. Desai, B. (1991): Introduction to Database Management system, Galgotia Publications

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Understand the concept of database management system.
2. Will able to manipulate & process data through SQL.
3. Understand the concept of database structure.

List of Discipline Specific Elective Papers: (Credit: 06 each)

Semester	Course Code (T+P)	Course Name	(L-T-P)	Credits
V	STAB5310+ STAB5311	Operations Research	4-0-4	6
V	STAB5320+ STAB5321	Time Series Analysis	4-0-4	6
V	STAB5330+ STAB5331	Econometrics	4-0-4	6
V	STAB5340+ STBB5341	Demography and Vital Statistics	4-0-4	6
VI	STAB6310+ STAB6311	Financial Statistics	4-0-4	6
VI	STAB6320 + STAB6321	Actuarial Statistics	4-0-4	6
VI	STAB6330+ STAB6331	Survival Analysis and Biostatistics	4-0-4	6
VI	STAB6393	Project Work		6

*Optional Dissertation or project work in place of one Discipline Specific Elective paper (DSE-4)(6 credits) in 6th Semester

STAB5310	OPERATIONS RESEARCH	4L:0T:0P	4 CREDITS

Course objectives:

The objectives of this course are

1. Students will learn about Operations Research.
2. To make student familiar with Transportation Problems.
3. To impart the knowledge of Game theory.
4. To impart the knowledge of Inventory Management.

UNIT I

Introduction to Operations Research, phases of O.R., model building, various types of O.R.problems. Linear Programming Problem, Mathematical formulation of the L.P.P, graphicalsolutions of a L.P.P. Simplex method for solving L.P.P. Charne's M-technique for solvingL.P.P. involving artificial variables. Special cases of L.P.P. Concept of Duality in L.P.P: Dual simplex method. Post-optimality analysis

UNIT II

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

UNIT III

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

UNIT IV

Inventory Management: ABC inventory system, characteristics of inventory system. EOQ Model and its variations, with and without shortages, Quantity Discount Model with price breaks.

Text /Reference Books:

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

STAB5311	**OPERATIONS RESEARCH LAB**	**0L:0T:4P**	**2 CREDITS**

(Using TORA/WINQSB/LINGO)

List of Practical

1. Mathematical formulation of L.P.P and solving the problem using graphical method,Simplex technique and Charne's Big M method involving artificial variables.
2. Identifying Special cases by Graphical and Simplex method and interpretation

a. Degenerate solution
b. Unbounded solution
c. Alternate solution
d. Infeasible solution

3. Post-optimality

a. Addition of constraint
b. Change in requirement vector
c. Addition of new activity
d. Change in cost vector

4. Allocation problem using Transportation model
5. Allocation problem using Assignment model
6. Networking problem

a. Minimal spanning tree problem
b. Shortest route problem

7. Problems based on game matrix

a. Graphical solution to mx2 / 2xn rectangular game
b. Mixed strategy

8. To find optimal inventory policy for EOQ modelsand its variations
9. To solve all-units quantity discounts model

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Understand the concept of Operations Research.

2. Understand the concept of solving Transportation Problems.
3. Understand the concept of Game theory.
4. Understand the concept of Inventory Management

STAB5320	TIME SERIES ANALYSIS	4L:0T:0P	4 CREDITS

Course objectives:

The objectives of this course are

1. To understand the students concept of times series.
2. To make student learn of trend continuation.
3. To familiarize students with Random Component.
4. To impart the knowledge of Seasonal Component continuation.

UNIT I

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

UNIT II

Trend Cont.: Method of moving averages. Detrending. Effect of elimination of trend on other components of the time series. Seasonal Component: Estimation of seasonal component by Method of simple averages, Ratio to Trend,

UNIT III

Seasonal Component cont: Ratio to Moving Averages and Link Relative method,Deseasonalization. Cyclic Component: Harmonic Analysis. Some Special Processes:Moving-average (MA) process and Autoregressive (AR) process of orders one and two,Estimation of the parameters of AR (1) and AR (2) – Yule-Walker equations.

UNIT IV

Random Component: Variate component method. Forecasting: Exponential smoothing methods, Short term forecasting methods: Brown's discounted regression, Box-Jenkins method and Bayesian forecasting. Stationary Time series: Weak stationarity, autocorrelation function and correlogram of moving average.

Text /Reference Books:

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

STAB5321	TIME SERIES ANALYSIS LAB	0L:0T:4P	2 CREDITS

List of Practical

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

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Understand the concept of times series.
2. Understand the concept of trend continuation .
3. Understand the concept of Random Component
4. Understand the concept of Seasonal Component continuation.

STAB5330	ECONOMETRICS	4L:0T:0P	4 CREDITS

Course objectives:

The objectives of this course are

1. To understand the students concept of econometrics.
2. To make student learn about autocorrelation .
3. To familiarize students with heteroscedasticity.
4. To impart the knowledge of autocorrelation.

UNIT I

Introduction: Objective behind building econometric models, nature of econometrics, model building, role of econometrics, structural and reduced forms. General linear model(GLM).Estimation under linear restrictions.

UNIT II

Multicollinearity: Introduction and concepts, detection of multicollinearity, consequences,tests and solutions of multicollinearity, specification error.

UNIT III

Generalized least squares estimation, Aitken estimators. Autocorrelation: concept,consequences of autocorrelated disturbances, detection and solution of autocorrelation.

UNIT IV

Heteroscedastic disturbances: Concepts and efficiency of Aitken estimator with OLS estimator under heteroscedasticity. Consequences of heteroscedasticity. Tests and solutionsof heteroscedasticity. Autoregressive and Lag models, Dummy variables, Qualitative data.

Text /Reference Books:

1. Gujarati, D. and Sangeetha, S. (2007): Basic Econometrics, 4th Edition, McGraw Hill Companies.
2. Johnston, J. (1972): Econometric Methods, 2nd Edition, McGraw Hill International.
3. Koutsoyiannis, A. (2004): Theory of Econometrics, 2nd Edition, Palgrave MacmillanLimited,
4. Maddala, G.S. and Lahiri, K. (2009): Introduction to Econometrics, 4th Edition, JohnWiley & Sons.

STAB5331	ECONOMETRICS LAB	0L:0T:4P	2 CREDITS

List of Practical

1. Problems based on estimation of General linear model
2. Testing of parameters of General linear model
3. Forecasting of General linear model
4. Problems concerning specification errors
5. Problems related to consequences of Multicollinearity
6. Diagnostics of Multicollinearity
7. Problems related to consequences of Autocorrelation (AR(I))
8. Diagnostics of Autocorrelation
9. Estimation of problems of General linear model under Autocorrelation
10. Problems related to consequences Heteroscedasticity
11. Diagnostics of Heteroscedasticity
12. Estimation of problems of General linear model under Heteroscedastic distance terms
13. Problems related to General linear model under (Aitken Estimation)
14. Problems on Autoregressive and Lag models.

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Understand the concept of econometrics.
2. Understand the concept of autocorrelation.
3. Understand the concept of heteroscedasticity.

4. Understand the concept of autocorrelation.

STAB5340	DEMOGRAPHYANDVITALSTATISTICS	4L:0T:0P	4 CREDITS

Course objectives:

The objectives of this course are

5. To understand the students concept of Population Theories.
6. To make student learn of collection & analysis of data.
7. To familiarize students with Stationary and Stable population.
8. To impart the knowledge of abridged life tables.

UNIT I

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

UNIT II

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

UNIT III

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

UNIT IV

Abridged Life Tables; Concept and construction of abridged life tables by Reed-Merrell method, Greville's method and King's Method. 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, Pearl's Vital Index, Gross Reproduction Rate (GRR) and Net Reproduction Rate (NRR).

Text /Reference Books:

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

STAB5341	DEMOGRAPHYANDVITALSTATISTICS LAB	0L:0T:4P	2 CREDITS

List of Practical

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

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

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Understand the concept of Population Theories.
2. Understand the concept of collection & analysis of data.
3. Understand the concept of Stationary and Stable population
4. Understand the concept abridged life tables.

STAB6310	FINANCIAL STATISTICS	4L:0T:0P	4 CREDITS

Course objectives:

The objectives of this course are

1. To understand the students the basic concept of Probability.
2. To make student learn of tools needed for option pricing.
3. To familiarize students with pricing derivatives.
4. To impart the knowledge of stochastic models in finance.

UNIT I

Probability review: Real valued random variables, expectation and variance, skewness and kurtosis, conditional probabilities and expectations. Discrete Stochastic Processes, Binomial processes, General random walks, Geometric random walks, Binomial models with state dependent increments.

UNIT II

Tools Needed For Option Pricing: Wiener process, stochastic integration, and stochastic differential equations. Introduction to derivatives: Forward contracts, spot price, forward price, future price. Call and put options, zero-coupon bonds and discount bonds

UNIT III

Pricing Derivatives: Arbitrage relations and perfect financial markets, pricing futures, put-callparity for European options, relationship between strike price and option price. StochasticModels in Finance: Discrete time process- binomial model with period one.

UNIT IV

Stochastic Models in Finance: Continuous time process- geometric Brownian motion. Ito'slemma, Black-Scholes differential equation, Black-Scholes formula for European options,Hedging portfolios: Delta, Gamma and Theta hedging. Binomial Model for Europeanoptions: Cox-Ross-Rubinstein approach to option pricing. Discrete dividends

Text /Reference Books:

1. Franke, J., Hardle, W.K. And Hafner, C.M. (2011): Statistics of Financial Markets: An Introduction, 3rdEdition, Springer Publications.
2. Stanley L. S. (2012): A Course on Statistics for Finance, Chapman and Hall/CRC

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STAB6311	FINANCIAL STATISTICSLAB	0L:0T:4P	2 CREDITS

(USING SPREADSHEET/ R)

List of Practical

1. To verify "no arbitrage" principle
2. To verify relationship between spot price, forward price, future price
3. To price future contracts
4. To verify put-call parity for European options
5. To construct binomial trees and to evaluate options using these trees
6. To price options using black – Scholes formula
7. To hedge portfolios using delta and gamma hedging
8. To hedge portfolios theta hedging
9. Pricing of call options using binomial model
10. Computation of dividends on call options as a percentage of stock price.
11. Computation of dividends on call options as a fixed amount of money.

12. Pricing of put options using binomial model
13. Call-put parity for options following binomial models.
14. Effect of dividends on put options.

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Understand the concept of probability.
2. Understand the concept of tools needed for option pricing.
3. Understand the concept of pricing derivatives.
4. Understand the concept of stochastic models in finance.

STAB6320	ACTUARIAL STATISTICS	4L:0T:0P	4 CREDITS

Course objectives:

The objectives of this course are

1. To understand the students concept of Insurance Applications.
2. To make student learn of premium principles.
3. To familiarize students with Survival Distribution and Life Tables.
4. To impart the knowledge of Life Insurance.

UNIT I

Introductory Statistics and Insurance Applications: Discrete, continuous and mixed probability distributions. Insurance applications, sum of random variables. Utility theory:Utility functions, expected utility criterion, types of utility function, insurance and utility theory.

UNIT II

Principles of Premium Calculation: Properties of premium principles, examples of premium principles. Individual risk models: models for individual claims, the sum of independent claims, approximations and their applications.

UNIT III

Survival Distribution and Life Tables: Uncertainty of age at death, survival function, timeuntil-death for a person, curate future lifetime, force of mortality, life tables with examples,deterministic survivorship group, life table characteristics, assumptions for fractional age,some analytical laws of mortality.

UNIT IV

Life Insurance: Models for insurance payable at the moment of death, insurance payable at the end of the year of death and their relationships. Life annuities: continuous life annuities,discrete life annuities, life annuities with periodic payments. Premiums: continuous and discrete premiums.

Text /Reference Books:

1. Dickson, C. M. D. (2005): Insurance Risk And Ruin (International Series On Actuarial Science), Cambridge University Press.
2. Bowers, N. L., Gerber, H. U., Hickman, J. C., Jones, D. A. And Nesbitt, C. J. (1997): Actuarial Mathematics, Society Of Actuaries, Itasca, Illinois, U.S.A.

STAB6321	ACTUARIAL STATISTICS LAB	0L:0T:4P	2 CREDITS

(Using Spreadsheet/R)

List of Practical

1. Risk computation for different utility models
2. Discrete and continuous risk calculations
3. Calculation of aggregate claims for collective risks
4. Calculation of aggregate claim for individual risks
5. Computing Ruin probabilities and aggregate losses
6. Annuity and present value of contract
7. Computing premium for different insurance schemes
8. Practical based on life models and tables

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Understand the concept of Insurance Applications.
2. Understand the concept of premium principles.
3. Understand the concept of Survival Distribution and Life Tables.
4. Understand the concept of Life Insurance.

STAB6330	**SURVIVAL ANALYSIS AND BIOSTATISTICS**	**4L:0T:0P**	**4 CREDITS**

Course objectives:

The objectives of this course are

1. To understand the students concept of survival analysis.
2. To make student learn of risk theory.
3. To familiarize students with stochastic epidemic models.
4. To impart the knowledge of statistical genetics.

UNIT I

Survival Analysis: Functions of survival times, survival distributions and their applications exponential, gamma, Weibull, Rayleigh, lognormal, death density function for a distribution having bath-tub shaped hazard function.Censoring Schemes: Type I, Type II and progressive or random censoring with biological examples. Estimation of mean survival time and variance of the estimator for Type I and Type II censored data with numerical examples. Non-parametric methods: Actuarial and Kaplan-Meier methods for estimating survival function and variance of the Estimator.

UNIT II

Competing Risk Theory: Indices for measurement of probability of death under competing risks and their inter-relations. Estimation of probabilities of death using maximum likelihood principle and modified minimum Chi-square methods. Theory of independent and dependent risks. Bivariate normal dependent risk model.

UNIT III

Stochastic Epidemic Models: Simple epidemic models, general epidemic model definition and concept (without derivation). Duration of an epidemic.

UNIT IV

Statistical Genetics: Introduction, concepts-Genotype, Phenotype, Dominance, Recessiveness, Linkage and Recombination, Coupling and Repulsion. Mendelian laws of Heredity, Random mating, Gametic Array .relation between genotypic array and gametic array under random mating. Distribution of genotypes under random mating. Clinical Trials:Planning and design of clinical trials, Phase I, II and III trials. Single Blinding

Text /Reference Books:

1. Lee, E.T. and Wang, J.W. (2003): Statistical Methods for Survival data Analysis, 3rd Edition, John Wiley and Sons.
2. Biswas, S. (2007): Applied Stochastic Processes: A Biostatistical and Population Oriented Approach, Reprinted 2ndCentral Edition, New Central Book Agency.
3. Kleinbaum, D.G. (1996): Survival Analysis, Springer.
4. Chiang, C.L. (1968): Introduction to Stochastic Processes in Bio Statistics, John Wiley and Sons.
5. Indrayan, A. (2008): Medical Biostatistics, 2nd Edition Chapman and Hall/CRC.

STAB6331	**SURVIVAL ANALYSIS AND BIOSTATISTICS LAB**	**0L:0T:4P**	**2 CREDITS**

List of Practical

1. To estimate survival function
2. To determine death density function and hazard function

3. To identify type of censoring and to estimate survival time for type I censored data
4. To identify type of censoring and to estimate survival time for type II censored data
5. To identify type of censoring and to estimate survival time for progressively type I censored data
6. Estimation of mean survival time and variance of the estimator for type I censored data
7. Estimation of mean survival time and variance of the estimator for type II censored data
8. Estimation of mean survival time and variance of the estimator for progressively type I censored data
9. To estimate the survival function and variance of the estimator using Non-parametric methods with Actuarial methods
10. To estimate the survival function and variance of the estimator using Non-parametric methods with Kaplan-Meier method
11. To estimate Crude probability of death
12. To estimate Net-type I probability of death
13. To estimate Net-type II probability of death
14. To estimate partially crude probability of death
15. To estimate gene frequencies

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Understand the concept of survival analysis.
2. Understand the concept of risk theory.
3. Understand the concept of stochastic epidemic models.
4. Understand the concept of statistical genetics.

STAB6393	**PROJECT WORK**		**6 CREDITS**

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

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