Shri Sangameshwar Education Society's

Sangameshwar College, Solapur [Autonomous]

Affiliated to Punyashlok Ahilyadevi Holkar Solapur University, Solapur

NAAC Accredited with 'A' Grade (III Cycle CGPA 3.39)

Academic Council 4(4.2)
26th March, 2022

UG Science Programme: B.Sc.-III to be implemented from A.Y. 2022-2023

System: Choice Based Credit System (CBCS) with SGPA and CGPA

B.O.S. in: Statistics

Structure of Choice Based Credit System for Undergraduate Science **Program**
B.Sc. III (Statistics) to be implemented from **A.Y.2022-2023**
Table:5

Semester	Course		Course Code	Teaching Scheme/week		
				Hours	Lectures	Credits
V	AECC-C	ENGLISH FOR COMMUNICATION-III	2231501	3.2	4	2
	DSE-1A	Theory Paper-IX: Statistical Inference-I	2231541	2.4	3	3
		Practical-IV: Statistical Inference-I & Statistical Inference-II	2231646	4	5	2
	DSE-2A	Theory Paper-X: Probability Distributions	2231542	2.4	3	3
		Practical-V: Probability Distributions & Probability Theory	2231647	4	5	2
	DSE-3A	Theory Paper-XI: Sampling Techniques	2231543	2.4	3	3
		Practical-VI: Sampling Techniques & Designs of Experiments	2231648	4	5	2
	ANY ONE from DSE-4A (1) & 4A (2)					
	DSE-4A (1)	Theory Paper-XII: Operations Research	2231544	2.4	3	3
		Practical-VII: Operations Research & Quality Management and Reliability Theory	2231649	4	5	2
	DSE-4A (2)	Theory Paper-XII: Medical Statistics	2231545	2.4	3	3
		Practical-VII: Operations Research & Quality Management and Reliability Theory	2231649	4	5	2
	SGSEC-3	Theory Paper-III: R-Software	2231546	2.4	3	2
		Total		**31.2**	**39**	**24**
	AECC-D	ENGLISH FOR COMMUNICATION-IV	2231601	3.2	4	2
	DSE-1B	Theory Paper-XIII: Statistical Inference-II	2231641	2.4	3	3

VI		Practical-IV: Statistical Inference-I & Statistical Inference-II	2231646	4	5	2
	DSE-2B	Theory Paper-XIV: Probability Theory	2231642	2.4	3	3
		Practical-V: Probability Distributions & Probability Theory	2231647	4	5	2
	DSE-3B	Theory Paper-XV: Designs of Experiments	2231643	2.4	3	3
		Practical-VI: Sampling Techniques & Designs of Experiments	2231648	4	5	2
	ANY ONE from DSE-4B (1) & 4B (2)					
	DSE-4B (1)	Theory Paper-XVI: Quality Management and Reliability Theory	2231644	2.4	3	3
		Practical-VII: Operations Research & Quality Management and Reliability Theory	2231649	4	5	2
	DSE-4B (2)	Theory Paper-XVI: Actuarial Statistics	2231645	2.4	3	3
		Practical-VII: Operations Research & Quality Management and Reliability Theory	2231649	4	5	2
		Total		**28.8**	**36**	**22**
Total Semester V and VI				**60**	**75**	**46**

Table: 6

Semester	Course		EXAMINATION Marks			Credits
			CA	SEE	Total	
V	AECC-C	ENGLISH FOR COMMUNICATION-III	15	35	50	2
	DSE-1A	Theory Paper-IX: Statistical Inference-I	30	70	100	3
	DSE-2A	Theory Paper-X: Probability Distributions	30	70	100	3
	DSE-3A	Theory Paper-XI: Sampling Techniques	30	70	100	3
	ANY ONE from DSE-4A (1) & 4A (2)	Theory Paper-XII: Operations Research Theory Paper-XII: Medical Statistics	30	70	100	3
	SEC-3	Theory Paper-III: R-Software	15	35	50	2
	Total		**135+15**	**315+35**	**450+50**	**16**
VI	AECC-D	Theory-V: ENGLISH FOR COMMUNICATION-IV	15	35	50	2
	DSE-1B	Theory Paper-XIII: Statistical Inference-II	30	70	100	3
	DSE-2B	Theory Paper-XIV: Probability Theory	30	70	100	3
	DSE-3B	Theory Paper-XV: Designs of Experiments	30	70	100	3
	ANY ONE from DSE-4B (1) & 4B (2)	Theory Paper-XVI: Quality Management and Reliability Theory Theory Paper-XVI: Actuarial Statistics	30	70	100	3
	DSE-1A &	Practical-IV:	30	70	100	4

	DSE-1B	Statistical Inference-I & Statistical Inference-II				
	DSE-2A & DSE-2B	Practical-V: Probability Distributions & Probability Theory	30	70	100	4
	DSE-3A & DSE-3B	Practical-VI: Sampling Techniques & Designs of Experiments	30	70	100	4
	DSE-4A & DSE-4B	Practical-VII: Operations Research & Quality Management and Reliability Theory	30	70	100	4
		Total	**240+15**	**560+35**	**800+50**	**30**
Total Semester V and VI			**405**	**945**	**1350**	**46**

CA: Continuous Assessment SEE: Semester End Examination

Note:

The above structure (Table-5 and Table-6) is for Sem-V and Sem-VI of the undergraduate B.Sc.-III programmes* under science faculty.

* **B.Sc.-III** Chemistry/Physics/Mathematics/Statistics/Electronics/Botany/Zoology.

DSE: Discipline Specific Elective Core Course (When a Student opts a particular course[$] as a principal course from the core courses opted at B.Sc.- II excluding Geography and Psychology).

$ Chemistry/Physics/Mathematics/Statistics/Electronics/Botany/Zoology

AECC: Ability Enhancement Compulsory Course SEC: Skill Enhancement Course

Passing in each course is compulsory. SGPA/CGPA and Total Marks will be calculated excluding AECC courses.

Programmes	Total Marks	Credits
B.Sc.-I	1200+100+50	52
B.Sc.-II	1300+50	56
B.Sc.-III	1250+100	46
Total	**3750+250+50**	**154**

PROGRAM OUTCOMES OF B.Sc. PROGRAM

PO1 Acquire skill, training and knowledge to enhance thinking, comprehension and application abilities to compete, succeed and excel globally**.**

PO2 Gain knowledge and experience (through theory, experiments, tutorials, projects and industrial / field visits), to achieve ultimate progress and improvement, to be capable of employment and meet the global competencies.

PO3 Identify, formulate and analyze problems. Create, select, and apply suitable techniques, resources, and modern scientific tools to accomplish verified conclusions with an understanding of the limitations.

PO4 Apply moral principles and commit to the norms of scientific practice in every endeavor. Validate expertise to conduct wide range of scientific experiments to solve problems.

PO5 Communicate efficiently scientific events with the Scientific community and with Society at large with capability to comprehend and pen operative reports and design documentation, make effective presentations, and give and receive clear instructions.

PO6 Reveal knowledge with thoughtful expression of the scientific principles in one's own work, as an individual member and capable leader in a team, to manage projects in multidisciplinary environments.

Programme Learning Outcomes in B.Sc. (Statistics)

The student graduating with the Degree B.Sc. (Statistics) should be able to

1. Demonstrate the ability to use skills in Statistics and different practicing areas for formulating and tackling Statistics related problems and identifying and applying appropriate principles and methodologies to solve a wide range of problems associated with Statistics.

2. Acquire

(i) fundamental/systematic or coherent understanding of the academic field of Statistics and its different learning areas and applications.

(ii) Procedural knowledge that creates different types of professionals related to subject area of Statistics, including professionals engaged in government/public service and private sectors;

(iii) skills in areas related to one's specialization area within the disciplinary/subject area of Statistics and emerging developments in the field of Statistics.

3. Recognize the importance of statistical modeling and computing, and the role of approximation and mathematical approaches to analyze the real problems using various

statistical tools.

4. Plan and execute Statistical experiments or investigations, analyze and interpret data/information collected using appropriate methods, including the use of appropriate statistical software including programming languages, and report accurately the findings of the experiment/investigations.

5. Demonstrate relevant generic skills and global competencies such as

(i) problem-solving skills that are required to solve different types of Statistics related problems with well-defined solutions, and tackle open-ended problems that belong to the disciplinary-area boundaries;

(ii) investigative skills, including skills of independent thinking of Statistics-related issues and problems;

(iii) communication skills involving the ability to listen carefully, to read texts and reference material analytically and to present information in a concise manner to different groups/audiences of technical or popular nature;

(iv) analytical skills involving paying attention to detail and ability to construct logical arguments using correct technical language related to Statistics and ability to translate them with popular language when needed;

(v) ICT skills;

(vi) personal skills such as the ability to work both independently and in a group.

6. Demonstrate professional behavior such as

(i) being objective, unbiased and truthful in all aspects of work and avoiding unethical, irrational behavior such as fabricating, falsifying or misrepresenting data or committing plagiarism;

(ii) the ability to identify the potential ethical issues in work-related situations;

(iii) appreciation of intellectual property, environmental and sustainability issues; and

(iv) promoting safe learning and working environment.

Students will acquire

(a) knowledge of Statistics and its scope and importance in various areas such as Medical, Engineering,

Syllabus for: DSE-1A

DSE-1A: Theory Paper-IX: **Statistical Inference-I (2231541)**	**Lectures 45 (Hours 36)**

Unit 1	**Point Estimation** 1.1: Notion of a parameter, parameter space, general problem of estimation, estimating an unknown parameter by point and interval estimation. 1.2: Point estimation: Definition of an estimator (statistic) & its S.E., distinction between estimator and estimate, Illustrative examples. 1.3: Properties of estimator: Unbiased estimator, biased estimator, positive and negative bias, examples of unbiased and biased estimators. Proofs of the following results regarding the unbiased estimators: (a) Two distinct unbiased estimators of $\varphi(\theta)$ give rise to infinitely many unbiased estimators of $\varphi(\theta)$. (b) If T is unbiased estimator of θ then $\varphi(T)$ is an unbiased estimator of $\varphi(\theta)$ provided $\varphi(.)$ is a linear function. (c) Sample variance is a biased estimator of the population variance. Illustration of unbiased estimator for the parameter and parametric function. 1.4: Relative efficiency of T_1 with respect to T_2, where T_1 and T_2 are unbiased estimators. Use of mean square error to modify the above definition for biased estimator. Minimum Variance Unbiased Estimator (MVUE) and Uniformly Minimum Variance Unbiased Estimator (UMVUE), uniqueness of UMVUE whenever it exists. Illustrative examples. 1.5: Consistency: Definition, proof of the following: (a) Sufficient condition for consistency (b) If T is consistent for θ and $\varphi(.)$ is a continuous function then $\varphi(T)$ is consistent for $\varphi(\theta)$. Illustrative examples	15
Unit 2	**Likelihood and Sufficiency** 2.1: Definition of likelihood functions as a function of the parameter θ for a random sample from discrete and continuous distributions. Illustrative examples. 2.2: Sufficiency: Concept of sufficiency, definition of sufficient statistic through conditional distribution and Neyman factorization criterion, Pitman - Koopman form and sufficient statistic. 2.3: Proof of the following properties of sufficient statistic: (a) If T is sufficient for θ then $\varphi(T)$ is also sufficient for θ provided $\varphi(.)$ is a one-to-one and on-to function. (b) If T is sufficient for θ then T is sufficient for $\varphi(\theta)$. 2.4: Fisher information function: Definition of information function, amount of information contained in a sample. Statement regarding equality of the information in $(X_1,X_2,\ldots..X_n)$ and in a sufficient statistic T, Concept of minimal sufficient statistic with illustrations to exponential family. Illustrative examples.	12
Unit 3	**Cramer – Rao inequality** 3.1: Statement and proof of Cramer – Rao inequality. Definition of Minimum Variance Bound Unbiased Estimator (MVBUE) of $\varphi(\theta)$. Proof of thefollowing results: (a) If MVBUE exists for θ then MVBUE exists for $\varphi(\theta)$, if $\varphi(.)$ is a linear function. (b) If T is MVBUE for θ then T is sufficient for θ. Examples and problems.	7
Unit 4	**Methods of Estimation** 4.1: Method of maximum likelihood, derivation of maximum likelihood estimators for parameters of standard distributions. Use of iterative	11

	procedure to derive MLE of location parameter μ of Cauchy distribution, Invariance property of MLE, relation between MLE and sufficient statistic. Illustrative examples. 4.2: Method of moments: Derivation of moment estimators for standard distributions. Illustrations of situations, where MLE and moment estimators are distinct and their comparison using mean square error (for uniform distribution). Illustrative examples. 4.3: Method of minimum chi-square: Definition, derivation of minimum chi-square estimator for the parameter. Illustrative examples.	

Course Outcomes: Course Outcomes (COs) On completion of the course, the students will be able to:

CO1: Describe various terms for point estimation, interval estimations to understand problem of statistical inference. List and study the properties of point estimators.

CO2: Explain the method to obtain estimators using maximum likelihood, method of moments, Information function. CO3 Demonstrate different situations with random sample from the standard distributions to obtain appropriate estimators.

CO3: Compare different estimators with random sample from the standard distributions with unknown parameters and examine the suitability of estimators.

CO4: Evaluate efficiency of estimators and justify the importance of Fisher information function.

CO5: Collect various situations to discuss about importance of an estimator of unknown parameters

Books Recommended

1. Kale, B. K.: A first Course on Parametric Inference
2. Rohatgi, V. K.: Statistical Inference
3. Rohatgi, V. K.: An introduction to Probability Theory and Mathematical Statistics
4. SaxenaH. C. and Surenderan : Statistical Inference
5. Kendall M. G. and Stuart A.: An advanced Theory of Statistics
6. Lindgren, B. W.: Statistical Theory
7. Lehmann, E. L.: Theory of Point Estimation
8. Rao,C.R.: Linear Statistical Inference
9. DudewiczC.J.and Mishra S.N.: Modern Mathematical Statistics
10. Fergusson,T.S.:Mathematical statistics.
11. Zacks,S.:Theory of Statistical Inference.
12. Cramer,H.:Mathematical Methods of Statistics.
13. CasselaG.and Berger R.L.: Statistical Inference.
14. Siegel, S.: Non-parametric Methods for the Behavioral Sciences.
15. Dr. P. G. Dixit, Dr. (Mrs.) V. R. Prayag, S. M. Patil, N. J. Subandh: Statistical Inference: Estimation, NiraliPrakashan, Pune

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Syllabus for: DSE-2A

DSE-2A : Theory Paper-X: **Probability Distributions (2231542)**		**Lectures 45 (Hours 36)**
Unit 1	**UnivariateContinuousProbabilityDistributions** 1.1: **Laplace (DoubleExponential)Distribution:**Probability density function withparameters(μ, λ), Natureoftheprobabilitycurve,Distributionfunction, Quartiles, Moment Generating Function, mean,variance, moments,β_1,β_2,$\gamma_1$andγ_2, Laplacedistributionas	15

	thedistributionofthedifferenceoftwoi.i.d.exponentialvariableswithparameterθ,examplesandproblems. 1.2: **LognormalDistribution:** Probability density functionwith parameters(μ,σ^2), Nature of the probability curve, mean, variance, median, mode, moments, $\beta_1,\beta_2,\gamma_1$and$\gamma_2$coefficients, Relation with N(μ,σ^2), examplesandproblems. 1.3: **CauchyDistribution:**Probability density functionwithparameters (μ,λ),natureoftheprobability curve,Distributionfunction, Quartiles, non-existence ofmoments, additive property fortwoindependent Cauchy variables (statementonly), statement of distribution of the samplemean, relationshipwithuniformandStudent's t distribution,distributionof$\frac{X}{Y}$whereXand Yarei.i.d.N(0,1),examplesandproblems. 1.4: **Weibull Distribution**: Probability density functions withparameters(α, β), distribution function, quartiles, mean and variance, coefficient ofvariation, relation with gamma and exponential distribution, examples and problems.	
Unit 2	**UnivariateandMultivariateProbabilityDistributions** 2.1: **Logisticdistribution:**Probability density functionswithparameters(μ, σ),c.d.f.,mean,mode,variance, skewness usingmode, applications. 2.2: **Pareto distribution**: Probability density functionswithparameters(α,β),mean, variance, mode, skewness usingmode,applications. 2.3: **Powerseriesdistribution**:Probability mass function,mean,mode,variance,Binomial, Poisson,Geometric andnegativebinomialdistributionasparticularcasesofpowerseriesdistribution.	12
Unit 3	**TruncatedDistributions** 3.1: Truncateddistributionasconditionaldistribution,truncationtotheright,leftandonboth sides. 3.2: BinomialdistributionB (n,p)lefttruncatedatX=0(valuezeronotobservable),it'sp.m.f,mean,variance. 3.3: PoissondistributionP(m),lefttruncatedatX=0(valuezeronotobservable),it'sp.m.f.,meanandvariance. 3.4: NormaldistributionN(μ,σ^2)truncated (a) Totheleftbelowa (b) To the right above b, (c) Tothe left below a and to the right above b, it'sp.d.f. and mean. 3.5: Exponentialdistributionwithparameterθleft truncatedbelowa, its probability density function,meanandvariance. 3.6: Examplesandproblems.	8
Unit 4	**4.1: Bivariate Normal Distribution:** Probability density function ofa bivariatenormaldistribution, BN(μ_1, μ_2, σ_1^2, σ_2^2, ρ) , Marginaland conditionaldistributions,identificationof parameters,conditionalexpectationand conditional variance, regression of Y on X and of Xon Y., independence and uncorrelated-nessimplyeachother,moment generating function andmoments.Distributionof	10

	$aX + bY + c$, wherea,bandcarerealnumbers. 4.2:**Cauchydistribution**: Cauchydistributionasthedistributionof $Z = \frac{X}{Y}$where, (X,Y)~BN (0,0,σ_1^2, σ_2^2, ρ) 4.3:Examplesandproblems.	

Course Outcomes: On completion of the course, the students will be able to:

CO1: Define various continuous probability distributions and outline the properties of probability density functions, cumulative distribution functions.

CO2: Compute moment generating function, raw moments, central moments of different continuous probability distributions.

CO3: Demonstrate the significance of the distributions and identify the real life situations for probability distributions.

CO4: Analyze the relationship between different continuous distributions using the nature of the distributions.

CO5: Determine and develop problem-solving techniques needed to accurately calculate probabilities.

CO6: Get idea of truncated distributions and relate it to real life situation

BooksRecommended:

1. CramerH.:MathematicalMethodsofStatistics,AsiaPublishingHouse,Mumbai.
2. Mood,A.M.,GraybillK,Bose.D.C.:IntroductiontoTheoryofStatistics.(Thirdedition) Mc-GrawHillSeries.
3. Lindgren B. W.: Statistical Theory (Third Edition),CollierMacmillan International Edition,Macmillan Publishing Co.Inc.NewYork.
4. Hogg,R.V.andCraigA.T.: IntroductiontoMathematicalStatistics(Third Edition), Macmillan Publishing Company, Inc.866,34dAvenue,NewYork,10022.
5. SanjayAroraandBansiLal:NewMathematicalStatistics(FirstEdition),SatyaPrakashan, 16/17698,NewMarket,NewDelhi,5(1989).
6. GuptaS.CandKapoorV.K.:FundamentalsofMathematicalStatistics,SultanChand andSons,88,Daryaganj,NewDelhi2.
7. RohatgiV.K.:AnIntroductiontoProbabilityTheoryandMathematical Statistics, Wiley EasternLtd.,NewDelhi.
8. Feller.W.:AnIntroductionofProbabilityTheoryanditsApplications,WileyEastern Ltd.Mumbai.
9. JhonsonandKotz:ContinuousUnivariateDistributionsIandII:DiscreteDistributions: MultivariateDistributions

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Syllabus for: DSE-3A

DSE-3A : Theory Paper-XI :**Sampling Techniques (2231543)**		**Lectures 45 (Hours 36)**
Unit 1	**BasicTerminologyandSimpleRandomSampling** **1.1: BasicTerminology:** Conceptof distinguishableelementaryunits,samplingunits,samplingframe,random sampling and non-random sampling. Advantages of sampling method	15

	over census method,objectivesofa samplesurvey,designinga questionnaire,Characteristicsofa goodquestionnaire, Conceptofsamplingandnon-sampling errors.Handlingofnon-responsecases. **1.2: Simplerandomsamplingforattributes** **(a)** Samplingfordichotomousattributes. Estimationof populationproportion, Sample proportion(p), asanestimatorofpopulationproportion(P), derivationof itsexpectation,standarderrorandestimatorofstandarderrorusingSRS WOR. **(b)** Npas anestimatorof totalnumberofunitsinthepopulationpossessingtheattributeof interest,derivationofitsexpectation, standarderrorandestimatorofstandarderror. **1.3: Determinationofthesamplesize** Determinationofthesamplesize(n)forthegiven: (a) Marginoferrorandconfidencecoefficient (b) Coefficientofvariationoftheestimatorandconfidencecoefficient.	
Unit 2	**StratifiedSampling** 2.1:Reallifesituationswherestratificationcanbeused. 2.2:Description of stratified sampling method where sample is drawn from individual stratumusingSRSWORmethod. (a) $\bar{y}_{st}$asan unbiased estimatorofpopulationmean $\bar{Y}$,derivationofits expectation,standard errorandestimatorofstandarderror. (b) N$\bar{y}_{st}$ asanestimatorofpopulationtotal,derivationofitsexpectation,standard error andestimatorofstandarderror. 2.3:Problemof allocation:Proportionalallocation,Neyman'sallocation andoptimum allocation,derivationoftheexpressionsforthestandarderrorsof theaboveestimators whentheseallocationsareused. 2.4:ComparisonamongstSRSWOR,stratificationwithproportionalallocatio nand stratificationwithoptimumallocation 2.5:Cost and variance analysis in stratified random sampling, minimization of variance for fixed cost, minimization of cost for fixed variance, optimum allocation as a particular case of optimization in cost and variance analysis.	15
Unit 3	**Other Sampling Methods** 3.1: **SystematicSampling:** (a) Reallifesituationswheresystematicsamplingisappropriate. Techniqueofdrawinga sampleusing systematic sampling. (b) Estimationofpopulationmeanandpopulationtotal,standarderrorofthe seestimators.	5

	(c) ComparisonofsystematicsamplingwithSRSWOR, ComparisonofsystematicsamplingwithSRSWORandstratifiedsampling inthe presenceoflineartrend. (d) IdeaofCircularSystematicSampling. 3.2: **ClusterSampling:** (a) Reallifesituationswhereclustersamplingisappropriate.Techniqueofdrawingasample usingclustersampling. (b) Estimationofpopulationmeanandpopulationtotal(withequalsizeclusters),standard erroroftheseestimators (c) Systematicsamplingasa particularcaseofclustersampling. 3.3: **TwoStageandMultiStageSampling:** Ideaoftwo-stageandmulti-stagesampling.	
Unit 4	**SamplingMethodsusingAuxiliaryvariables** 4.1: **RatioMethod** (a) Conceptofauxiliaryvariableanditsuseinestimation, Situationswhere Ratiomethodisappropriate. (b) Ratioestimatorsofthepopulationmeanandpopulationtotalandtheirstandard errors(withoutderivations),estimatorsofthesestandarderrors, Relativeefficiencyofratioestimators withthatof SRSWOR. 4.2: **RegressionMethod** (a) Situationswhere Regressionmethodisappropriate. (b) Regressionestimatorsofthepopulationmeanandpopulationtotalandtheirstandard errors(withoutderivations),estimatorsofthesestandarderrors.Commentsregardingbiasinestimation (c) Relativeefficiencyofregression estimatorswiththatof i. SRSWOR ii. Ratioestimator	5
Course Outcomes: The students shall get CO1: Basic knowledge of complete enumeration and sample, sampling frame, samplingdistribution, sampling and non-sampling errors, principal steps in sample surveys,limitations of sampling etc. CO2: Introduced to various statistical sampling schemes such as simple, stratified andsystematic sampling. CO3: An idea of conducting the sample surveys and selecting appropriate sampling techniques CO4: Knowledge about comparing various sampling techniques CO5: Concept and use of Auxiliary variable to estimate Ratio and Regression methods.		

BooksRecommended

1. Cochran,W.G:SamplingTechniques,WileyEasternLtd.,NewDelhi.

2.Sukhatme,P.V.andSukhatme,B.V.:SamplingTheoryofSurveyswithApplications, IndianSocietyofAgriculturalStatistics,NewDelhi.

3. DesRaj:SamplingTheory.

4. DarogaSinghandChoudharyF.S. :TheoryandAnalysisofSampleSurveyDesigns, WileyEasternLtd.,NewDelhi.

5. Murthy,M.N:SamplingMethods,IndianStatisticalInstitute,Kolkata.

6. Mukhopadhay,Parimal:TheoryandMethodsofSurveySampling,PrenticeHall.

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Syllabus for: DSE-4A(I)

DSE-4A(I): Theory Paper-XII: **Operations Research (2231544)**		**Lectures 45 (Hours 36)**
Unit 1	**Linearprogramming** 1.1: **Basicconcepts:** Statementof theLinearProgrammingProblem(LPP),formulation of problem asL.P. problem.Definition of(i)aslackvariable, (ii)asurplusvariable.L.P. problemin (i) canonicalform,(ii)standardform.Definitionof(i)asolution,(ii)afeasiblesol ution, (iii)basicvariableandnon-basicvariable,(iv) a basicfeasiblesolution,(v)a degenerate andanon-degeneratesolution,(vi)anoptimalsolution. 1.2: **SolutionofL.P.P.** (a) Graphical Method: Solution space, obtaining an optimal solution, unique and non- unique optimal solutions. (b) Simplex Method:Initial basic feasible solution (IBFS) is readily available: obtaining an IBFS, criteria for deciding whether obtained solution is optimal, criteria for unbounded solution, and morethan one optimal solution. (c) IBFS not readily available: introduction of artificial variable, Big-M method, modified objective function, modifications and applications of simplex method to L.P.P., criterion for no solution.Examples and problems. 1.3: **DualityTheory**: (a) Writingdualofaprimalproblem,solutionofL.P.P.withartificialvariable (b) Examplesandproblems.	15
Unit 2	**TransportationandAssignmentProblems** **2.1: Transportationproblem** (a) Transportation problem (T.P.), statement of T.P., balanced and unbalanced T.P. (b) Methods of obtaining initial basic feasible solution of T.P. (i)North West corner rule (ii)Method of matrix minima (least cost method) (iii) Vogel's approximation (VAM). (c) MODI method of obtaining optimalsolution of T.P, uniqueness and non-uniqueness of optimal solutions, degenerate solution. Examples and problems.	12

	2.2: AssignmentProblem (a) Statement ofan assignment problem, balanced and unbalanced assignment problem,relation withT.P,optimalsolutionofanassignmentproblemusingHungarianmethod. (b) Examplesandproblems. 2.3:**SequencingProblem** Introduction.Statementofproblem, Procedureofprocessingnjobsontwomachines, Procedureofprocessingnjobsonthreemachinesandmmachines, Computationsof elapsedtimeandidletimes, Examplesandproblems.	
Unit 3	**DecisionTheory** i. Introduction,stepsindecisiontheoryapproach. ii. Typeofdecisionmakingenvironments. iii. Decision making under uncertainty: Criteria of optimism, criteria of pessimism, equallylikelydecisioncriterion,criterionofregret. iv.Decision making under risk: Expected monetary value, expected opportunity loss, expectedvalueofperfectinformation. v.Examplesandproblems.	8
Unit 4	**SimulationTechniques** 4.1: Meaningof simulation,MonteCarlosimulation,advantagesanddisadvantagesof simulation,definitionandpropertiesof randomnumbers,generationofpseudorandom numbers, techniquesofgeneratingrandomnumbersfromuniformdistribution,Testsfor randomness anduniformity, 4.2: Random variategeneration using inversec. d. f.method,random Variate generationfrom Bernoulli,Binomial,Poisson,Geometric, Exponentialandnormaldistributions.	10
Course Outcomes: On completion of the course, the students will be able to: **CO1:** Recall the concept of linear programming. **CO2:** Represent given situation into LPP and formulate the objective function, constraints and the network diagram. **CO3:** Apply the techniques of solving LPP to obtain optimal solution. **CO4:** Classify the solutions and interpret them according to the situations. **CO5:** Apply decision theory for appropriate profit. **CO6:** Use simulation technique to generate random numbers and and use it to generate model sample from various distributions.		

BookRecommended

1.GassE.:LinearProgrammingMethodandApplications,NarosaPublishing House, NewDelhi.
2.ShrinathL.S.:LinearProgramming.
3.TahaH.A.:Operationresearch–AnIntroduction,FifthEdition,PrenticeHallofIndia, NewDelhi.
4.Saceini,Yaspan,Friedman:OperationsResearchMethodandProblems, WileyInternationalEdition.
5.Shrinath,L.S.:LinearProgramming,AffiliatedEast-WestPressPvt.Ltd., NewDelhi.
6.Phillips,D.T.,Ravindra,A.,Solberg,J.:OperationsResearchPrinciplesandPractice,JohnWiley andSonsInc.
7.Sharma,J.K.:MathematicalModelsinOperationsResearch,TauMcGrawHillPublishingCompanyLtd.,NewDelhi.

8.Kapoor,V.K.;OperationsResearch,SultanChandandSons,NewDelhi.
9.Gupta,P.K.andHiraD.S.:OperationsResearch,S.ChandandCompany Ltd.,NewDelhi.
10.LucDevroye:Non-UniformRandomVariateGeneration,Springer–Verlag,NewYork.
11.Gentle,J.E.:RandomNumberGenerationandMonteCarloMethods,Springer- Verlag.
12.Robert,C.P.andCasella,G.:MonteCarloStatisticalmethods,Springer-Verlag.
13.Rubinstien,R.Y.:SimulationandMonteCarloMethod,JohnWiley,NewYork

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Syllabus for: DSE-4A(II)

DSE-4A(II): Theory Paper-XII : **Medical Statistics (2231545)**		**Lectures 45 (Hours 36)**
Unit 1	**Epidemiology** 1.1: Introduction to Epidemiology 1.2: Odds, odds ratio, relative risk 1.3: Estimation of odds ratio (OR), Confidence interval for OR. Relation 1.4: Symmetry in square contingency tables, collapsing tables and Simpson's paradox.	12
Unit 2	**Clinical trials** 2.1: General information on history of drug discovery including Louis Pasteur (rabies and small pox), Ronald Ross and malaria, Alexander Fleming and penicillin, Jonas Salk and polio, cholera, asthma, diabetes, blood pressure, heart attack, arthritis. 2.2: Phases of clinical trial, purpose, duration, cost, drug regulatory bodies, ICH, statistical analysis plan, clinical study report.	12
Unit 3	**Design of clinical trials** **3.1:** Phases of clinical trial, purpose, duration, cost, drug regulatory bodies, ICH, statistical analysis plan, clinical study report. **3.2:** Parallel designs, case control studies, longitudinal studies, safety studies**.** **3.3:** Treatments, 2 periods cross over design.	12
Unit 4	**Bioequivalence and bio-availability** 4.1: Bioequivalence and bio-availability, non-inferiority trial. 4.2: Practice based medical research, evidence based medicine	9
Course Outcomes: On completion of the course, the students will be able to: CO1: Understand basic statistical concepts in the medical field CO2: Select methodology of statistical testing correctly along with study design in the field CO3: Practice univariate analysis with using statistical software		

CO4: Interpret results of statistical analysis to be used in a real-life medical application

Books Recommended

1. Course on mathematical and statistical Ecology : Kluwer publishing Holland,A. P .Gore and S. A, Paranjape (200)
2. " Introduction to Statistical Ecology : M.B. Kulkarni, V.R. Prayag, SIPF Academy,Nasik (2004)
3. Introduction to Categoril Data Analysis : Alan Agrasti John wiley (1996)
4. Introduction to Randomized Controlled clinical Trials: J.N.S. Matthews : Chapman and Hall (2006)
5. Statistical Issues in drug Development : Stephen Sann (John Wiley) 2000
6. Clinical Trials – A methodological perpective : Steven Diantadosi (John Wiley 2000)
7. Fundamentals of Clinics Trials: L.M. Friedmon, C.D. Forbes, D.L. Demats (TT)Spinner
8. Epidemiologic Analysis : Steve selvin : (Oxford 200)
9. Statistical Methods for Health Sciences: M.M. Shoukni, C.A. Pavse(1999) CPC Press.
10. Statistical Analysis of Epidemiologic Data Steve Salvin, Ph.D. : Oxford 1999)
11. Lecture Notes on Medical Statistics : A.P. Gore, S.A.Paranjpe and M.B. Kulkarni

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Syllabus for: SGSEC-3

SEC-3: R- Software (2231546)		**Lectures 45 (Hours 36)**
Unit 1	**Fundamental of R** 1.1:Introduction to R, Data Types, Data input/output, Creation of vector using commands: c() , rep() , seq(), scan(). 1.2:Creation of data frame using commands: data frame, edit, Arithmetic operation on vectors. 1.3:Diagrammatic and Graphical representation of data- Simple bar diagram, subdivided bar diagram, pie diagram, histogram, frequency polygon, ogive curves, Box plot.	12
Unit 2	**Descriptive Statistics:** 2.1: Measures of Central Tendency- A.M. G.M. H.M., Median, Mode, Partition values. 2.2: Measures of Dispersion- Range, Quartile deviation, mean deviation, standard deviation, CV. 2.3: Bivariate Data: Correlation and Regression in R.	11
Unit 3	**Simulation of Random Numbers** 3.1: Simulation in R for Discrete distributions- Bernoulli, Binomial and Poisson distribution. 3.2: Simulation in R for Continuous distributions- Exponential and	11

	Normal distribution	
Unit 4	**Hypothesis testing in R** 4.1: Tests of Hypothesis: t- test (one sample), t- test (two samples), Paired t- test and F- test, Chi-square test for goodness of fit 4.2: Large sample tests. One way ANOVA.	11
Course Outcomes: **Students are able to** CO1. Various application of probability distribution in daily life. CO2. Use of R – Software to solve statistical problems. CO3. Know different parametric and non-parametric tests with their applications CO4. Analyze sequential tests with different sample procedure. CO5. Analysis of ANOVA using R SOFTWARE		

BookRecommended

1. Learning R: A Step-by-Step Function Guide to Data Analysis 1st Edition by Richard Cotton(Author)
2. The Art of R Programming, Norman Matloff, CengageLearning
3. R for Everyone, Lander, Pearson
4. Siegel, S. (1956), Nonparametric Statistics for the Behavioral Sciences, McGraw-Hill International, Auckland
5. R Cookbook, PaulTeetor, Oreilly
6. R in Action, Rob Kabacoff, Manning

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SEM-VI

Syllabus for: DSE-1B

DSE-1B: Theory Paper-XIII : **Statistical Inference-II (2231641)**		**Lectures 45 (Hours 36)**
Unit 1	**IntervalEstimation** 1.1:Notionofintervalestimation,definitionofconfidenceinterval,lengthof confidence interval,confidence bounds.Definition ofPivotalquantityandits use in obtainingconfidenceintervalsandbounds. 1.2:Intervalestimationforthefollowingcases: (a) Mean μ of normal distribution (σ^2 known and σ^2 unknown). (b) Varianceσ^2ofnormaldistribution(μknownandμ unknown). (c) Differencebetweentwomeansμ_1-μ_2, (i) for asamplefrombivariatenormalpopulation, (ii) forsamplesfromtwoindependentnormalpopulations. (d) Ratioofvariancesforsamplesfromtwoindependentnormal populations. (e) Meanofexponentialdistribution.	11

	(f) Populationproportion and differenceoftwopopulationproportionsoftwo independentlargesamples. (g) Population median using order statistics. 1.3:Illustrative examples.	
Unit 2	**ParametricTests** 2.1: Statisticalhypothesis,problemsoftestingofhypothesis,definitionsandillustrationsof (i)simplehypothesis(ii)compositehypothesis,criticalregion,type-I andtype-IIerror,probabilitiesoftype-I &type-IIerrors.Powerofa test,p-value,sizeofatest,levelof significance,problemofcontrollingprobabilitiesoftype-I&type-IIerrors. 2.2: DefinitionofMostPowerful(MP)test.Statementandproof(sufficientpart)ofNeyman-Pearson(NP)lemmaforsimplenullhypothesisagainstsimplealternativehypothesis forconstructionofMPtest.ExamplesofconstructionofMPtestoflevel α. 2.3: Powerfunctionofatest,powercurve,definitionofuniformlymostpowerful(UMP)levelαtest.Use of NP lemma for constructing UMP levelsα testfor one-sided alternative.Illustrativeexamples. 2.4: LikelihoodRatioTest:Procedureoflikelihood ratiotest,statementofitsproperties,LikelihoodRatiotestinvolvingmeanandvarianceofnormalpopulation.	13
Unit 3	**SequentialTests** 3.1: Generaltheoryof sequentialanalysisanditscomparisonwithfixedsampleprocedure. 3.2: Wald'sSPRTof strength(α,β),forsimplenullhypothesisagainstsimplealternative hypothesis. 3.3: Illustrationsforstandarddistributionslikebinomial,Poisson,exponential andnormal.Graphicalandtabularprocedureforcarryingout the test.Illustrativeexamples.	9
Unit 4	**Non-parametricTest** 4.1:Notionof non-parametricstatisticalinference(test)anditscomparisonwithparametric statisticalinference.Conceptofdistributionfreestatistic. 4.2:Testprocedureof: (a) Run test for one sample (i.e. test forrandomness) and run test fortwo independentsampleproblems. (b) Signtestforonesampleandtwosamplepaired observations. (c) Wilcoxon'ssignedranktestforonesampleandtwosamplepairedobservations. (d) Mann-WhitneyU-test(twoindependentsamples).Mediantest.	12

	(e) KolmogorovSmirnovtestforoneandfortwoindependentsamples.	

Course Outcomes: On completion of the course, the students will be able to:

CO1: Describe the terms involved in the problem of testing of hypothesis to develop MP and UMP tests.

CO2: Compute Type I error and Type II error to understand the concept of MP and UMP tests.

CO3: Demonstrate MP test using NP Lemma and construction of LRT and SPRT

CO4: Explain the situations when UMP test exists

CO5: Justify the use of parametric or non-parametric tests.

CO6: Develop Likelihood Ratio Test and illustrate that MP test is special case of LRT

BooksRecommended

1. Kale,B.K.:AfirstCourseonParametricInference
2. Rohatgi,V.K.: StatisticalInference
3. Rohatgi,V.K.: AnintroductiontoProbabilityTheoryandMathematical Statistics
4. SaxenaH.C.andSurenderan:StatisticalInference
5. KendallM.G.andStuartA.:An AdvancedTheoryofStatistics
6. Lindgren,B.W.:StatisticalTheory
7. CasselaG.andBergerR.L.:StatisticalInference
8. Lehmann,E.L:TestingofStatisticalHypothesis
9. Rao,C.R.:LinearStatisticalInference
10. DudewiczC.J.andMishraS.N.:ModernMathematicalStatistics
11. Fergusson,T.S.:Mathematicalstatistics.
12. Zacks,S.:TheoryofStatisticalInference.
13. Cramer,H.:MathematicalMethodsofStatistics.
14. Gibbons,J.D.:Non-parametricStatisticalInference.
15. Doniel:AppliedNon-parametricStatistics
16. Siegel,S.: Non-parametricMethodsforthebehavioralsciences.
17. Kunte,S.;Purophit, S.G.andWanjale, S.K.:Lecture notes on Non-parametric Tests.

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Syllabus for: DSE-2B

DSE-2B: Theory Paper-XIV: **Probability Theory (2231642)**		**Lectures 45 (Hours 36)**
Unit 1	**OrderStatistics** 4.1: Order statistics for arandom sample of size n from a continuous distribution, Joint distribution,definition,derivationofdistributionfunctionanddensityfunctionoftheithorderstatistic,particularcasesfori=1andi=n. 4.2: Derivationofjointp.d.f.ofith andjth orderstatistics,statementofdistributionof thesamplerange. 4.3: Distributionofthesamplemedianwhenn is odd. 4.4: ExamplesandProblems	10

Unit 2	**ConvergenceandLimitTheorem** 2.1:**Convergence:** Definition ofconvergenceofsequenceofrandomvariables (a) In probability (b) In distribution (c) In quadratic mean. (d) If $X_n \xrightarrow{P}$ X then g(Xn) $\xrightarrow{P}$ g(X) where g(.) is continuous function (without proof.) (e) Examples and problems. 2.2:**WeakLawofLargeNumbersandCentralLimitTheorem** (a) Weaklawoflargenumbers(WLLN)statementandprooffori.i.d.randomvariables withfinitevariance. (b) Central limit theorem: Statement and proof for i.i.d. random variables with finitevariance,proofbasedonm.g.f. (c) SimpleexamplesbasedonBernoulli,binomial,Poissonandchi-square distribution.	12
Unit 3	**FiniteMarkovChains** 3.1:**Basicconcepts:** Definitionandexamplesof stochastic process,classificationofgeneralstochasticprocess intodiscrete–continuous time, discrete –continuous state space, type ofstochastic process,Examplesandproblems. 3.2:**Markovchain:** Definition and examples of Markovchain, stochastic matrix, transition probability matrix,Chapman-Kolmogorovequation(statementonly),n steptransitionprobability matrix,classificationof states,simpleproblems.Stationaryprobabilitydistribution, applications.Examplesandproblems. 3.3:**ContinuousMarkovchain:** Purebirthprocess,Poissonprocess,birthand deathprocess(Derivationsnotexpected).Examplesandproblems.	12
Unit 4	**Game Theory** **4.1:** Meaning, two person zero-sum game, pure and mix strategies, Pay off tables, saddle points, Minimax and Maximin principles, Dominance principles **4.2:** Algebraic Method to solve 2×2 Game, Graphical Method **4.3:** Examples and problem**s.**	11

Course Outcomes:Students are able to

CO1: Understand concept of Order statistics and application of order statistics in different fields.

CO2: Understand Convergence and Weak Law of Large Numbers. Solve Convergence and WLLN problems.

CO3: Markov Chain 1. Understand Markov Chain, Solve problems on Markov Chain. Understand Stochastic Processes. Solve partial on Stochastic Processes.

CO4: UnderstandGame theory, Solve problems onGame Theory.

BooksRecommended

1. CramerH.:MathematicalMethodsofStatistics,AsiaPublishingHouse,Mumbai.
2. LindgrenB.W.:StatisticalTheory(ThirdEdition),CollierMacmillan International Edition,MacmillanPublishingCo.Inc.NewYork.
3. Hogg,R.V.andCraigA.T.:Introduction toMathematical Statistics(ThirdEdition), MacmillanPublishingCompany,Inc.866,34dAvenue,NewYork,10022.
4. SanjayAroraandBansiLal:NewMathematicalStatistics(FirstEdition),SatyaPrakashan16/ 17698,NewMarket,NewDelhi,5(1989).
5. GuptaS.CandKapoorV.K.:FundamentalsofMathematicalStatistics,SultanChandand Sons,88,Daryaganj,NewDelhi2.
6. RohatgiV.K.:AnIntroductiontoProbabilityTheoryandMathematicalStatistics,Wiley EasternLtd.,NewDelhi.
7. MedhiJ:StochasticProcesses.Wiley EasternLtd.NewDelhi.
8. Hoel,PortandStone:IntroductiontoStochasticProcesses,HoughtonMifflin.
9. Feller.W.:AnIntroduction to Probability TheoryanditsApplications.WileyEastern Ltd.Mumbai.
10. BhatB.R.:ModernProbabilityTheory.
11. KarlinandTaylor:StochasticProcess.
12. RossS:ProbabilityTheory.
13. BhatB.R.:StochasticModels: AnalysisandApplications.NewAgeInternational.
14. Zacks S.: Introduction to Reliability Analysis, Probability Models and Statistical Methods,SpringerVerlag.
15. TahaH.A.:Operationresearch–AnIntroduction,Fifthedition,PrenticeHallofIndia, NewDelhi.
16. BarlowR.E.andProschanFrank:StatisticalTheoryofReliabilityandLifeTesting.Holt.Rineb artandWinstonInc.,NewYark
17. SinhaS.K.:ReliabilityandLifeTesting,SecondEdition,WileyEastern Publishers, NewDelhi.
18. Trivedi R. S.:Probability and Statisticswith Reliability and Computer Science Application,Prentice–HallofIndiaPvt.Ltd.,NewDelhi.
19. ParimalMukhopadhyaya:AnIntroductiontotheTheoryofProbability.WorldScientific Publishing.

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Syllabus for: DSE-3B

DSE-3B: Theory Paper-XV: **Designs of Experiments (2231643)**		**Lectures 45 (Hours 36)**
Unit 1	**SimpleDesignsofExperiments I** 1.1:**BasicConcepts:**Basic terms in design of experiments: Experimental unit, treatment, layout of an experiment. (a) Basic principles of design of experiments: Replication,randomizationand local control. (b) Choiceofsizeandshapeofaplotforuniformitytrials,theempiricalformul	10

	aforthe varianceperunitareaofplots. 1.2:**CompletelyRandomizedDesign (CRD)** (a) Application of the principles of design of experiments in CRD, layout, model, assumptionsandinterpretations. (b) Estimationofparameters,expectedvaluesofmeansumofsquares,co mponentsof variance. (c) Breakupoftotalsumofsquaresintocomponents. (d) Techniqueofonewayanalysisofvariance(ANOVA)andit'sapplicati onstoCRD. (e) Testingforequalityfor treatment effectsanditsinterpretation.F-testfortestingH_0,testforequalityoftwo specifiedtreatmenteffects.	
Unit 2	**SimpleDesignofExperimentsII** 2.1:**RandomizedBlockDesign(RBD)** (a) Application of the principles of design of experiments in RBD, layout, model, assumptionsandinterpretations. (b) Estimation of parameters, expected values of mean sum of squares, componentsofvariance. (c) Breakupoftotalsumofsquaresintocomponents. (d) Techniqueoftwowayanalysisofvariance(ANOVA)anditsapplication stoRBD. (e) Testsandtheirinterpretations,testforequalityoftwospecifiedtreatment effects,comparisonoftreatmenteffectsusingcriticaldifference(C.D.).I deaofmissingplottechnique. (f) Situationswheremissingplottechniqueisapplicable. (g) AnalysisofRBDwithsinglemissingobservation. 2.2:**LatinSquareDesign (LSD)** (a) Application of the principles of design of experiments in LSD, layout, model, assumptionsand interpretations. (b) Breakupoftotalsum of squaresintocomponents. (c) Estimationofparameters,expectedvaluesofmeansumofsquares, componentsof variance.Preparationofanalysisofvariance(ANOVA)table. (d) Tests andtheirinterpretations,testforequalityoftwospecified treatment effects, comparisonoftreatmenteffectsusingcriticaldifference (C.D.).AnalysisofLSD withsinglemissingobservation. (e) IdentificationofreallifesituationswhereCRD,RBD and LSD are used.	15
Unit 3	**Efficiencyofdesign andANOCOVA** **3.1: Efficiencyofdesign** (a) Concept and definition of efficiency of a design. (b) EfficiencyofRBDoverCRD. (c) EfficiencyofLSD overCRD andLSD overRBD. 3.2:**AnalysisofCovariance(ANOCOVA) withoneconcomitantvariable** (a) Purposeof analysisofcovariance. (b) Practicalsituations whereanalysisofcovarianceisapplicable. (c) Model foranalysis ofcovariance in CRD and RBD. Estimation ofparameters(derivationsarenotexpected).Preparation ofanalysisofcovariance (ANOCOVA) table,testforβ=0,testfor equalityoftreatmenteffects(computationaltechniqueonly).	10

	Note: Forgivendata,irrespectiveoftheoutcomeofthetestofregressioncoefficient(β), ANOCOVAshouldbecarriedout.	
Unit 4	**FactorialExperiments** (a) Generaldescriptionoffactorialexperiments, 2^2 and2^3 factorialexperimentsarrangedinRBD. (b) Definitionsofmaineffectsandinteractioneffectsin 2^2 and2^3 factorialexperiments. Model,assumptions and its interpretation. (c) PreparationofANOVAtablebyYate'sprocedure,testformaineffectsandinteraction effects. (d) Generalideaandpurposeofconfoundinginfactorialexperiments. (e) Total confounding (Confounding only one interaction):ANOVA table, testing main effectsandinteractioneffects. (f) PartialConfounding(Confoundingonlyoneinteractionperreplicate): ANOVAtable, testingmaineffectsandinteractioneffects. (g) Construction of layout in total confounding and partial confounding in 2^3 factorialexperiment.	10

Course Outcomes: On completion of the course, the students will be able to:

CO1: Identify relationships between cause and effect, planning and designing the experiments.

CO2: Outline interactions among causative factors through factorial designs.

CO3: Apply different experimental designs to real life situations.

CO4: Analyze collected information through the experiments planned according to different designs using ANOVA and ANCOVA techniques.

CO5: Validate the design employed in real life situations using residual analysis.

CO6: Design a lay out of different statistical designs.

BooksRecommended

1.Federer,W.T.:ExperimentalDesign,OxfordandIBHpublishingCompany,NewDelhi.

2.Cochran,W.G.andCox,G.M.:ExperimentalDesign,JohnWileyandSons,Inc.,NewYork.

3.Montgomery,D.C.:DesignandAnalysisofExperiments,WileyEasternLtd.,NewDelhi.

4. Das, M. N. and Giri, N. C. : Design and Analysis of Experiments, Wiley Eastern Ltd., New Delhi.

5.Goulden,G.H.:MethodsofStatisticalAnalysis,AsiaPublishingHouse,Mumbai.

6.Kempthrone,O.:DesignandAnalysisofExperiments,WileyEasternLtd.,NewDelhi.

7.Snedecor,G.W.andCochran,W.G.:StatisticalMethods,AffiliatedEast-WestPress,New Delhi.

8.Goon,Gupta,Dasgupta:FundamentalofStatistics,Vol.IandII,TheWorldPressPvt. Ltd.Kolkata.

9.Gupta,S.C.andKapoor,V.K.:Fundamentals ofAppliedStatistics,S.Chand&Sons, NewDelhi.

10.C.F.JeffWu,MichaelHamada:Experiments,PlanningAnalysisandParameterDesign Optimization.

DSE-4B(I): Theory Paper-XVI: **Quality Management and Reliability Theory (2231644)**		**Lectures 45 (Hours 36)**
Unit 1	**QualityTools** Meaninganddimensions ofquality,qualityphilosophy, Magnificenttoolsofquality: Histogram, Checksheet, Paretodiagram, causeandeffectdiagram, scatterdiagram, controlchart,flowchart.Deming'sPDCAcyclefor continuousimprovementsandits applications.IS & ISO	
Unit 2	**ProcessControl** CUSUMchart,tabularform,useof thesechartsformonitoringprocessmean.Moving averageandexponentiallyweightedmovingaveragecharts.Introductionto six-sigma methodology,DMAICcycleandcasestudies.	
Unit 3	**ProductControl** SamplingInspectionplans forattributeinspection:ConceptofAQL,LTPD, Consumer'srisk,and producer'srisk,AOQ,AOQL,OC,ASNandATI.Description of Singleanddoublesamplingplanswithdeterminationofaboveconstants.	
Unit 4	**Reliability Theory** 4.1:Binarysystem:Blockdiagram,definitionofbinarycoherentstructureandillustrations. 4.2:Coherent systemof component (at most three)- a) Series b) Parallelc) 2 out of 3 system. 4.3:Minimal cut, minimal pathrepresentation of system.Reliabilityofbinarysystem:reliabilityofsystemsh(p)(mentioned in 4.2),whencomponentsare independent and identically distributed with common probability p of operating. 4.4:Ageing Properties: Definitions, Hazard rate, hazard function, survival function, concept ofdistributionswithincreasinganddecreasing failurerate(IFR,DFR).Relationshipbetween survivalfunctionandhazardfunction,densityfunctionand hazardrate 4.5: Derivationsof theresults: (a) Hazard rateofaseriessystem ofcomponentshavingindependentlife time's summationof componenthazardrates. (b) Lifetimeofseriessystem ofindependentcomponents with independent IFR life times is IFR. 4.6:Examples on exponential and Weibull distributions.	
Course Outcomes: Students are able to **CO1:** Understand the various Quality Tools. **CO2:** ApplySPCtools and DMIC cycle. **CO3:** Understand ProcessControl,smallshift control charts. **CO4:** Solve Problems on ProcessControl. **CO5:** Understand the OC curve,ASN,AOQ,AOQLand other definitions. **CO6:** Construct OC curve andASN value for Sampling plan **CO7:** UnderstandSixSigma methodology and construct the Six Sigma control char		

Books Recommended

1. IntroductiontoqualityControl–MontgomeryD.C.
2. QualityControlandIndustrialstatisticsDuncanAJ
3. StatisticalQualityControlbyELGrant
4. Zacks S.: Introduction to Reliability Analysis, Probability Models
5. Barlow, R.E. and Proschan Frank: Statistical Theory of Reliability and Life Testing,HoltRinebart and Winston Inc., New York.
6. Sinha S.K.: Reliability and Life Testing, Second Edition, Wiley Eastern Ltd. New Delhi.
7. Trivedi R.S.: Probability and Statistics with Reliability and Computer Science Application, Prentice – Hall of India Pvt. Ltd., New Delhi.
8. Dr. B.G. Kore and Dr. P. G. Dixit: Statistical Methods-II, 4th Edition, December, 2017, NiraliPrakashan, Pune.

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Syllabus for: DSE-4B(II)

DSE-4B(II): Theory Paper-XVI: **Actuarial Statistics (2231645)**		**Lectures 45 (Hours 36)**
Unit 1	**Introduction and Feasibility of Insurance Business** 1.1: Insurance companies as business organizations, Role of insurance business in Economy. Concept of risk and their types. 1.2: Introduction of terms: premium, policy, policyholder. 1.3: Role of Statistics in insurance business. 1.4: Expected value principle. Concept of utility function. Feasibility of insurance business.	7
Unit 2	**Survival Distribution** 2.1: Time- until death random variable, its distribution function and survival function in actuarial notation. 2.2: Force of mortality. Curtate future life random variable, its probability mass function and survival function in actuarial notation. 2.3: Deferred probability.	8
Unit 3	**Models for Life Insurance** 3.1: Introduction of simple and compound interest rate policy. 3.2: Different types of Interest rates. Insurance payable at the end of the year of death, present value random variable, actuarial present value. 3.3: Derivation of actuarial present value for n-year term life insurance, whole life insurance and n-year endowment insurance.	12
Unit 4	**Annuitiesand Premiums** 4.1: Annuities – certain, annuity due, annuity immediate. 4.2: Discrete life annuities: n-year temporary life annuity due and a whole life annuity due, present value random variables of the payment, and their actuarial present values. 4.3: Concept of a loss random variable. Equivalence principle. Computation of fully discrete premium for n-year term life insurance,	18

	whole life insurance and endowment insurance.	

Course Outcomes: On completion of the course, the students will be able to:
CO1: Recall the concepts of financial mathematics and probability theory.
CO2: Explain terms used in insurance business and survival analysis.
CO3: Calculate actuarial present values and amount of premium for insurance policy.
CO4: Classify risks into pure and speculative risk.
CO5: Compare statistical distributions of life length random variable on the basis of survival curves and force of mortality curves.
CO6: Construct life tables for different age groups of people.

Books Recommended

1. Bowers N.L. Jr., H.S.Gerber, J.C. Hickan, D.A.Jones, C.J.Nesbitt, (1997). Actuarial Mathematics, Society of Actuaries, U.S.
2. Deshmukh, S. R. (2009). Actuarial Statistics, Universities Press, Hyderabad, India.
3. Actuarial Mathematics, Society of Actuaries,ltasca,lllinois,U.S.A.2nd Ed.(1997)
4. Spurgeon E.T. (1972); Life Contingencies, Cambridge University Press. Neill, A. Life Contingencies, Heinemann

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Practical-IV: DSE-1A & DSE-1B:

Statistical Inference-I & Statistical Inference-II (2231646), (2231647)

1. Pointestimationbymethodofmomentsfordiscretedistributions.
2. Pointestimationbymethodofmomentforcontinuousdistributions.
3. Pointestimationbymethodofmaximumlikelihood(oneparameter).
4. Pointestimationbymethodofmaximumlikelihood(twoparameters).
5. Pointestimationbymethodofminimumchi-square.
6. Intervalestimationoflocationandscaleparametersofnormaldistribution(single sample).
7. Intervalestimationofdifferenceoflocationandratioofscaleparametersofnormal distribution(twosamples).
8. Intervalestimationforpopulationproportionanddifferencebetweentwopopulation proportions.
9. Intervalestimationforpopulationmedianusingorderstatistics.
10. ConstructionofMPtest.
11. ConstructionofUMPtest.
12. ConstructionofSPRTfor Binomial,Poissondistributions, Graphical representationof procedure.
13. Constructionof SPRTfor exponential andnormaldistribution,graphical representation ofprocedure.
14. Non-Parametric Runtest(foroneandtwoindependentsamples).

15.Non-Parametric SigntestandWilcoxon'ssignedranktest(foroneandtwo samplespairedobservation).
16. Non-Parametric Mann-WhitneyU-test(fortwoindependentsamples).
17.Non-Parametric Mediantest(fortwolargeindependentsamples)
18.Non-Parametric Kolmogorov-Smirnovtest(foroneandtwoindependentsamples).

Practical-V: DSE-2A & DSE-2B: Probability Distributions &Probability Theory (2231648)

(8 practical's weightage is assigned to Project)

1)) Fitting of truncated Binomial distribution.
2) Fitting of truncated Poisson distribution.
3) Data input/output, diagrammatic and graphical representation of data using R-Software.
4) Model sampling from Laplace distribution and Cauchy distribution using R Software.
5) Model sampling from Pareto distribution and weibull distribution using R software.
6) Model sampling from truncated Binomial and truncated Poison distributions.
7) Model sampling from truncated Normal and Exponential distributions using R Software.
8) Model sampling from Bivariate Normal distribution using R Software.
9) Application of Bivariate Normal distribution-I.
10) Application of Bivariate Normal distribution-II.

Practical-VI: DSE-3A & DSE-3B: Sampling Techniques &Designs of Experiments (2231648)

1. Analysis of CRD and RBD.
2. Analysis of Latin Square Design (LSD).
3. Missing Plot Technique for RBD and LSD with one missing observation.
4. Efficiency of i)RBDoverCRDandii)LSDoverCRDandRBD.
5. AnalysisofCovarianceinCRD.
6. AnalysisofCovarianceinRBD.
7. Analysisof2^2 and 2^3 FactorialExperiment.
8. TotalConfounding.
9. PartialConfounding.
10. SimpleRandomSamplingforAttributes.
11. DeterminationofSampleSizeinSRSforVariablesandAttributes.
12. StratifiedRandomSampling–I
13. StratifiedRandomSampling–II
14. RatioMethodofEstimation.
15. RegressionMethodofEstimation.
16. SystematicSampling.
17. ClusterSampling.
18. Two-StageandMulti-StageSampling.

Practical-VII: DSE-4A(I) & DSE-4B(I): Operations Research &Quality Management and Reliability Theory (2231649)

1.L.P.P.bysimplexmethodI(Slack Variable)

2.L.P.P.bysimplexmethodII(BigMmethod)

3.Transformationproblem-I.

4.Transformationproblem-II.(Degeneracy)

5.Assignmentproblem.

6.SequencingProblem.

7.DecisionTheory.

8.SimulationI(Discretedistribution)

9.SimulationII(Continuousdistribution)

10.EWMA-Chart.

11.CUSUM chart.

12.Sixsigmalimitsformean.

13.Singlesamplingplan-I(Smallsample).

14.Singlesamplingplan-II(Largesample).

15.Doublesamplingplan-I(Smallsample).

16.Doublesamplingplan-II(Largesample).

17.ReliabilityTheory- I (Block diagram, Structure function, Minimal cut, Minimal path, Reliability)

18. ReliabilityTheory- II (Hazard rate, Hazard function, Survival function, IFR, DFR, Examples on Exponential and Weibull distributions)

Practical-VII: DSE-4A(I) & DSE-4B(II) **: Operations Research & Actuarial Statistics**

Practical-VII: DSE-4A(II)& DSE-4B(I) **: Medical Statistics & Quality Management and Reliability Theory**

Practical-VII: DSE-4A(II) & DSE-4B(II)**: Medical Statistics & Actuarial Statistics**

Note :

1. Students are allowed to use any type of calculator or computer using any software like MS-Excel, R-Software etc. for computations in practical.
2. Students must complete the practical to the satisfaction of the concerned teacher.
3. Students must produce laboratory journal along with completion certificate signed by the HoD of Statistics at the time of practical examination.

4. Nature of SEE (at the end of Sem-VI)in a practical for 70 marks: A student has to attempt any two questions out of four asked, each for 25 marks. 10 marks are reserved for the assessment of journal. Also, 10 marks are reserved for the oral examination. Duration of practical examination is 4 hours per practical paper.
5. Nature of CA of a practical for 30 marks: Continuous Assessment is based on active participation in laboratory work/ assessment of the laboratory test/ Project completion and viva.
6. Combined marks of SEEs and CAs of all practical's will be considered for the practical assessment of SEE and CA respectively .

Teaching-Learning-Evaluation: Equipment/Tools/Methodsetc.
Use of class room teaching, laboratory, computers, calculators, data collection, testsetc

Signature :

Name : *Dr. P.M. Dargopatil*
Chairman
BOS in Statistics

Academic Council 5(5.2)
15th June, 2022

CBCS BSc. PART III SEMESTER V

AECC- C

ENGLISH FOR COMMUNICATION-III (2231501)

SEE- 35 + CA- 15 = 50 marks

COURSE CREDITS 03L+01T=04 COURSE CONTACT HOUR 60

Course Objectives:

- To make the students comprehend English language in general
- To enhance the quest for knowledge and correct pronunciations
- To strengthen oral and written communication skills with grammar accuracy
- To galvanize soft skills

Course Outcomes:

By the end of the course the students will be able to:

- Use oral and written English effectively and fluently

- Demonstrate their knowledge of correct pronunciations
- Apply English language skills and grammar accuracy in clearing competitive examinations
- Apply their knowledge of Soft Skills to succeed in career as well as in practical life.

Module No and Title:
Module I: Prose

1. The Gift of the Magi: O' Henry
2. The Homecoming: Rabindranath Tagore
3. The California's Tale: Mark Twain

Module II: Poetry

1. The Solitary Reaper: William Wordsworth
2. The Queen's Rival: Sarojini Naidu
3. Oh! How I faint When I of You Do Write (Sonnet No 80) : William Shakespeare
4. The Road Not Taken: Robert Frost

Module. III: Pronunciation Skills

1) Basic Sounds in English
2) IPA Symbols
3) Phonetic Transcription
4) Stress and Intonation

Module. IV: Soft Skills

1. Types of 21st Century Skills
2. Learning Skills (4Cs)
3. Preparation for Employment

Reference Books:

BA/BSC Part III Compulsory English Literary Mindscapes-I PAH Solapur University, Solapur (With 20% new additions & changes)

CBCS BSc. PART III SEMESTER VI

AECC- D

ENGLISH FOR COMMUNICATION-IV (2231601)

SEE- 35 + CA- 15 = 50 marks

COURSE CREDITS 03L+01T=04 COURSE CONTACT HOUR 60

Course Objectives:

- To make the students comprehend English language in general
- To enhance the quest for knowledge and correct pronunciations
- To strengthen oral and written communication skills with grammar accuracy
- To galvanize soft skills

Course Outcomes:

By the end of the course the students will be able to:

- Use oral and written English effectively and fluently
- Demonstrate their knowledge of correct pronunciations
- Apply English language skills and grammar accuracy in clearing competitive examinations
- Apply their knowledge of Soft Skills to succeed in career as well as in practical life.

Module No and Title:

Module. I: Prose

1. Growing Up:	Joyce Cary
2. God See the Truth, but Waits:	Leo Tolstoy
3. On the Rule of The Road:	A. G. Gardiner

Module. II: Poetry

1. Sita:	Toru Dutt
2. My Last Duchess:	Robert Browning
3. Ode to Beauty:	John Keats
4. Song: Go and Catch a Falling Star:	John Donne

Module. III: Grammar

1. Simple and Multiple Sentences
2. Direct and Indirect Speech

Module. IV: Soft Skills

1. Literacy Skills
2. Life Skills
3. Employability Skills

Reference Books:

BA/BSC Part III Compulsory English Literary Mindscapes-I PAH Solapur University Solapur (With 20% new additions & changes)

Chairman
BOS in English