HINDI MAHAVIDYALAYA
(ARTS, COMMERCE, SCIENCE & PG CENTRE)
(Autonomous & NAAC RE-ACCREDITED)
DEPARTMENT OF STATISTICS

B.Sc(MSCs) & M.Sc(Applied Statistics)

M.Sc(Applied Statistics) : Sem-I

Paper-1 - LINEAR ALGEBRA AND LINEAR MODELS(LA AND LM)

UNIT	TOPICS	LINK
Unit-I	Gram-Schmidt Orthogonalization process	https://www.math.tamu.edu/~yvorobet/MATH304-2011A/Lect3-05web.pdf
	Orthogonalization Projection	https://julia.quantecon.org/tools_and_techniques/orth_proj.html
Unit-II	Caley-Hamilton theorem algebric	https://www.sciencedirect.com/topics/mathematics/cayley-hamilton-theorem
	Spectral decomposition of a real symmetric matrix	https://mast.queensu.ca/~br66/419/spectraltheoremproof.pdf
	Matrix inequalities	https://www.imng.uni-stuttgart.de/mst/files/LectureNotes.pdf
	cauchy-Schwartz and Hadamard Inequalites	https://en.wikipedia.org/wiki/Cauchy%E2%80%93Schwarz_inequality
Unit-III	Guass-Markov theorem	https://math.unm.edu/~fletcher/JPG/mch4.pdf
	BLUE for Linear functions of parameters	https://www.gaussianwaves.com/2014/07/best-linear-unbiased-estimator-blue-introduction/
	Aitkens generalized least squares	https://bookdown.org/eugenesun95/510Notes/the-aitken-model.html
	concept of Multicollinearity	https://www.wallstreetmojo.com/multicollinearity/
Unit-IV	Simple Linear regression	https://www.simplilearn.com/what-is-simple-linear-regression-in-machine-learning-article
	Multiple and Partial Correlations	https://www.jstor.org/stable/2281314
	Polynomial regression	https://serokell.io/blog/polynomial-regression-analysis
	Uses of orthogonal polynomials	https://towardsdatascience.com/why-should-we-use-orthogonal-polynomials-b42b36f158a7

PAPER-2 -PROBABILITY THEORY

UNIT	TOPICS	LINK
Unit-I	Probabilty as a measure	https://en.wikipedia.org/wiki/Probability_measure
	Riemann-Stieltjes integration	https://users.math.msu.edu/users/yanb/327ch6.pdf
	Condition expectation and conditional variances	https://statweb.rutgers.edu/hcrane/Teaching/582/lectures/chapter18-condexp.pdf

Unit-II	Inversion theorem	https://www.sciencedirect.com/topics/mathematics/inversion-theorem
	Statement of Levy's continuity theorem	https://en.wikipedia.org/wiki/L%C3%A9vy%27s_continuity_theorem
	Probability and moment inequalities	www.markirwin.net/stat110/Lecture/inequalities.pdf
Unit-III	Borel-Cantelli Lemma	http://www.columbia.edu/~ks20/stochastic-I/stochastic-I-BC.pdf
	Borel 0-1 law	http://theanalysisofdata.com/probability/6_6.html
	convergence in probability	https://www.statlect.com/asymptotic-theory/convergence-in-probability
	Slutzky's theorem and its applications	https://www.statisticshowto.com/slutskys-theorem/
Unit-IV	Weak law of large numbers	https://www.sciencedirect.com/topics/mathematics/weak-law-of-large-number
	Strong law of large numbers	https://www.sciencedirect.com/topics/mathematics/strong-law-of-large-number
	Central limit Theorem	https://www.investopedia.com/terms/c/central_limit_theorem.asp

PAPER-3 - DISTRIBUTION THEORY AND ESTIMATION THEORY(DT and ET)

UNIT	TOPICS	LINK
Unit -I	Compound distributions	https://www.youtube.com/watch?v=0YIk44FdHAo
	Truncated distributions	https://en.wikipedia.org/wiki/Truncated_normal_distribution
	Bivariate Normal distributions	https://www.probabilitycourse.com/chapter5/5_3_2_bivariate_normal_dist.php
Unit-II	Functions of random variables	https://www.probabilitycourse.com/chapter3/3_2_3_functions_random_var.php
	Jacobian of transformations	https://math.etsu.edu/multicalc/prealpha/chap3/chap3-3/part3.htm
	Sampling Distributions of Sample mean and variance	https://stats.libretexts.org/Bookshelves/Introductory_Statistics/Book%3A_Introductory_Statistics_(Lane)/09%3A_Sampling_Distributions/9.05%3A_Sampling_Distribution_of_the_Mean
	Distributions of sample range	https://www.jstor.org/stable/2334973
Unit-III	Concepts of point estimation	https://www.britannica.com/science/point-estimation
	Criterion for good estimator	http://aboutlowmortgagerate.blogspot.com/2008/01/what-is-criteria-of-good-estimator.html
	Rao-Blackwell theorem	https://www.youtube.com/watch?v=2yPd7sybI2M
	Lehmann-Scheff's theorem	https://www.oreilly.com/library/view/probability-random-variables/9781118393956/OEBPS/c09-sec1-0009.htm
Unit-IV	Method of moments	https://web.stanford.edu/class/archive/cs/cs109/cs109.1218/files/student_drive/7.3.pdf
	MLE and its properties	https://engineering.purdue.edu/ChanGroup/ECE645Notes/StudentLecture08.pdf
	Definition of CAN and BAN	https://core.ac.uk/download/pdf/82631923.pdf

	Conjugate families	https://www.bayesrulesbook.com/chapter-5.html

PAPER - 4 - SAMPLING THEORY AND SURVEYS (ST)

UNIT	TOPICS	LINK
Unit-I	Probability proportional to size(PPS)	https://link.springer.com/referenceworkentry/10.1007/978-94-007-0753-5_2269
	Cumulative total and Lahari's methods	https://article.sciencepublishinggroup.com/html/10.11648.j.sjams.20150305.13.html
	Horwitz-Thompson	https://online.stat.psu.edu/stat506/lesson/3/3.3
	Hansen - Horwitz estimators for population mean	https://online.stat.psu.edu/stat506/lesson/3/3.2
Unit-II	Ratio Method of Estimation	https://www.youtube.com/watch?v=us3PWR8Y5BU
	Ratio estimators in stratified random sampling	https://www.webpages.uidaho.edu/~chrisw/stat422/RatioandStRS.pdf
	Regression estimators in SRS with Difference Estimator	http://www.stat.wmich.edu/naranjo/stat5630/ch6.pdf
	Separate and combined regression estimators	https://scholar.google.co.in/scholar?q=Separate+and+combined+regression+estimators&hl=en&as_sdt=0&as_vis=1&oi=scholart
Unit-III	Cluster Sampling	https://www.voxco.com/blog/cluster-sampling/
	Sub- sampling(Two- Stage only)	http://home.iitk.ac.in/~shalab/sampling/chapter10-sampling-two-stage-sampling.pdf
Unit-IV	Planning of Sample Surveys	https://www.bmj.com/about-bmj/resources-readers/publications/epidemiology-uninitiated/5-planning-and-conducting-survey
	Pilot Survey	https://www.questionpro.com/blog/pilot-survey/
	Non-Sampling errors	http://home.iitk.ac.in/~shalab/sampling/chapter13-sampling-non-sampling-errors.pdf

M.Sc(Applied Statistics) : Sem-II

PAPER 1 - STATISTICAL INFERENCE

UNITS	TOPICS	LINKS
Unit-I	Types of errors	https://www.expii.com/t/types-of-error-overview-comparison-8112
	Critical region	https://www.ncl.ac.uk/webtemplate/ask-assets/external/maths-resources/statistics/hypothesis-testing/critical-region-and-confidence-interval.html
	Concepts of UMP tests	https://en.wikipedia.org/wiki/Uniformly_most_powerful_test

	Neymann-Pearson lemma	https://en.wikipedia.org/wiki/Neyman%E2%80%93Pearson_lemma
Unit -II	Concepts of unbiased and consistent tests	https://towardsdatascience.com/linear-regression-with-ols-unbiased-consistent-blue-best-efficienestimator-359a859f757e
	Likelihood Ratio Criterion with simple applications	https://en.wikipedia.org/wiki/Likelihood-ratio_test
	Confidence Intervals	https://www.scribbr.com/statistics/confidence-interval/
	The concept of robustness in testing	https://www.statisticshowto.com/robust-statistics/
Unit-III	Wilcoxon Signed rank test for one sample and paired samples	https://www.statstest.com/wilcoxon-signed-rank-test/
	Two sample problems based on Wilcoxon Mann Whitney test	https://www.unm.edu/~marcusj/WMW.pdf
	Kolmogorov test	https://en.wikipedia.org/wiki/Kolmogorov%E2%80%93Smirnov_test
	Friedman test for two-way layout (randomized block)	https://www.statisticshowto.com/friedmans-test/
Unit-IV	Notions of sequential vs fixed sample size techniques	https://www.researchgate.net/publication/319608403_Fixed_vs_Sequential_Sample_Size_Designs
	Termination property of SPRT	https://en.wikipedia.org/wiki/Sequential_probability_ratio_test
	Statement of optimality properties of SPRT	https://link.springer.com/chapter/10.1007/978-1-4612-1880-7_26

PAPER 2 -- APPLIED REGRESSION ANALYSIS (ARA)

UNITS	TOPICS	LINKS
Unit-1	Extra sum of squares principle	https://www.statisticshowto.com/extra-sums-of-squares-definition/
	Orthogonal columns in the X-matrix	https://math.stackexchange.com/questions/386050/matrix-with-orthogonal-columns
	Introduction to examination of residuals	https://math.usask.ca/~laverty/Stats%20851%20&%20443/Stats%20851%20443/Stats%20851%20443%20Section%2010%20-%20Examination%20of%20Residuals.pdf
	Detecting of Outliers	https://www.analyticsvidhya.com/blog/2021/05/detecting-and-treating-outliers-treating-the-odd-one-out/
Unit-2	Stagewise regression procedure	https://en.wikipedia.org/wiki/Stepwise_regression
	Ridge regression	https://online.stat.psu.edu/stat857/node/155/
	Robust regression	https://en.wikipedia.org/wiki/Robust_regression
Unit-3	Logistic regression model	https://online.stat.psu.edu/stat462/node/207/
	Multiple Logistic regression	https://en.wikipedia.org/wiki/Multinomial_logistic_regression
	Sigmoid curve	https://www.toppr.com/ask/content/concept/sigmoid-population-growth-curve-266595/

Unit-4	Non-linear regression	https://www.investopedia.com/terms/n/nonlinear-regression.asp
	ML estimation	https://en.wikipedia.org/wiki/Maximum_likelihood_estimation
	The Gauss-Newton method	https://www.statisticshowto.com/gauss-newton-method/
	Gompertz model	https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0178691

PAPER 3 --MULTIVARIATE DATA ANALYSIS (MDA)

UNITS	TOPICS	LINKS
Unit -1	Concepts of Bivariate and multivariate random variables	https://www.scribbr.com/frequently-asked-questions/univariate-vs-bivariate-vs-multivariate/
	Multinomial distribution and its properties	https://www.statlect.com/probability-distributions/multinomial-distribution
	Distribution of sample mean vector	https://online.stat.psu.edu/stat505/lesson/5/5.1
	Maximum likelihood estimates of parameters	https://online.stat.psu.edu/stat415/lesson/1/1.2
Unit -2	Statement of Wishart distribution and its properties	https://www.statlect.com/probability-distributions/wishart-distribution
	Hotelling's T^2 statistic	https://www.statisticshowto.com/hotellings-t-squared/
	Mahalanobis D^2 statistic	https://www.statisticshowto.com/mahalanobis-distance/
Unit-3	Concepts of Discriminant analysis	https://www.statisticssolutions.com/discriminant-analysis/
	Fisher's Linear Discriminant Function	https://towardsdatascience.com/fishers-linear-discriminant-intuitively-explained-52a1ba79e1bb
	Path analysis and computation of path analysis	https://en.wikipedia.org/wiki/Path_analysis_(statistics)
	Metric and non-metric multidimensional scaling methods	https://en.wikipedia.org/wiki/Multidimensional_scaling
Unti-4	Principal component analysis	https://en.wikipedia.org/wiki/Principal_component_analysis
	Factor analysis	https://en.wikipedia.org/wiki/Factor_analysis
	Orthogonal factor model construction	http://sfb649.wiwi.hu-berlin.de/fedc_homepage/xplore/tutorials/mvahtmlnode72.html
	Cluster analysis	https://www.forsta.com/what-is-cluster-analysis/

PAPER 4-- DESIGN OF EXPERIMENTS (DOE)

UNITS	TOPICS	LINKS
Unit-I	One- way and two-way classifications	https://theintactone.com/2019/03/06/brm-u5-topic-10-analysis-of-variance-one-way-and-two-way-classifications/

	Fisher Least Significance Difference (L.S.D) test	https://www.graphpad.com/support/faq/fishers-least-significant-difference-lsd-test/
	Duncan's Multiple range test (DMRT)	https://www.statisticshowto.com/duncans-multiple-range-test/
Unit-II	Concepts of Balanced partial confounding	http://home.iitk.ac.in/~shalab/anova/chapter10-anova-partial-confounding.pdf
	Fractional replications of factorial designs-one-half replication of 2^3 &2^4 design	https://online.stat.psu.edu/stat503/book/export/html/672
	Resolution of a design	https://support.minitab.com/en-us/minitab/21/help-and-how-to/statistical-modeling/doe/supporting-topics/factorial-and-screening-designs/what-is-design-resolution/
	Split-plot design	https://www.statology.org/split-plot-design/
Unit-III	Balanced incomplete block design (BIBD)	https://www.stat.purdue.edu/~bacraig/notes514/topic14a.pdf
	Intra-block analysis	https://www.jstor.org/stable/2527762
	Youden-square design	http://www2.imm.dtu.dk/courses/02411/slideall_1.pdf
Unit-IV	Concept of Response surface methodology (RSM)	https://en.wikipedia.org/wiki/Response_surface_methodology
	The Method of Steepest ascent	https://krisrs1128.github.io/stat424_f21/posts/2021-08-17-week12-1/
	Response surface designs	https://online.stat.psu.edu/stat503/book/export/html/681

M.Sc(Applied Statistics) : Sem-III

PAPER 1 - OPERATIONAL RESEARCH-I

UNIT	TOPIC	LINK
Unit-I	Definition and scope of OR	https://www.businessmanagementideas.com/personnel-management/operation-research/operation-research-definition-scope-and-techniques/6556
	Models and their solutions	https://www.britannica.com/topic/operations-research/Deriving-solutions-from-models
	Primal dual relation	https://hithaldia.in/faculty/sas_faculty/Dr_D_K_Jana/Class%20Note-MM_401-MODEL-2-Duality.pdf
	Parametric Programming	https://en.wikipedia.org/wiki/Parametric_programming#:~:text=Parametric%20programming%20is%20a%20type,in%20a%20thesis%20from%201952.
Unit-II	Queuing Theory	https://www.investopedia.com/terms/q/queuing-theory.asp#:~:text=Queuing%20theory%20is%20the%20study,cost%2Deffective%20services%20and%20systems.
	Distribution of Arrival and interarrival	http://ecoursesonline.iasri.res.in/mod/resource/view.php?id=90035
	Sequencing and Scheduling Problems	http://ecoursesonline.iasri.res.in/mod/resource/view.php?id=90029#:~:text=Sequencing%20problems%20are%20concerned%20with,time%20or%20overall%20cost%20etc.

	Distribution of death process	https://en.wikipedia.org/wiki/Birth%E2%80%93death_process
Unit-III	Inventory	http://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000025MS/P001336/M010144/ET/1527249935E-textofChapter5Module1.pdf
	ABC analysis	https://cleartax.in/s/abc-analysis
	Networks	http://gn.dronacharya.info/MIEDept/Downloads/Questionpapers/VIISem/OR/Unit-3/network-technique.pdf
	PERT, CPM, Network problems	https://www.studocu.com/in/document/pes-university/management-science-operations-research/pert-and-cpm-techniques/17727287
Unit-IV	Integer Programming Problem	https://www.navingirlscollege.com/pdf/e-notes/mathematics/Integer%20Programming%20%20Part%201.pdf
	Stochastic Programming Problem	https://en.wikipedia.org/wiki/Stochastic_programming#:~:text=In%20the%20field%20of%20mathematical,but%20follow%20known%20probability%20distributions.

PAPER 2- FORECASTING MODELS

UNIT	**TOPIC**	**LINK**
Unit-I	Forecasting	https://www.ijamtes.org/gallery/40.july%20ijmte%20-%20693.pdf
	Smoothing Techniques	https://corporatefinanceinstitute.com/resources/business-intelligence/data-smoothing/
	Stationary stochastic processes	https://en.wikipedia.org/wiki/Stationary_process
	Standard error of autocorrelation estimates	https://www.sciencedirect.com/topics/mathematics/autocorrelation
	Bartlett's approximation	https://thebusinessprofessor.com/en_US/research-analysis-decision-science/bartletts-test-statistics-definition
Unit-II	Linear Stationary Models	https://www.oreilly.com/library/view/time-series-analysis/9780470272848/11_chap03.html
	Auto-covariance generating function and spectrum	https://www.degruyter.com/document/doi/10.1515/9780691218632-020/html?lang=en
	partial autocorrelation function (PACF)	https://en.wikipedia.org/wiki/Partial_autocorrelation_function#:~:text=In%20time%20series%20analysis%2C%20the,not%20control%20for%20other%20lags.
	ACF and PACF for M.A.(q) spectrum for M.A	https://towardsdatascience.com/identifying-ar-and-ma-terms-using-acf-and-pacf-plots-in-time-series-forecasting-ccb9fd073db8
	The ARMA(1,1) process and its properties	https://real-statistics.com/time-series-analysis/arma-processes/arma11-processes/
Unit-III	Model Identification	https://prinsli.com/classification-of-modelling-in-operations-research/
	Model estimation	https://catalog.extension.oregonstate.edu/sites/catalog/files/project/pdf/em8718.pdf
Unit-IV	Model diagnostic checking–Checking the stochastic model	https://www.investopedia.com/terms/s/stochastic-modeling.asp

	Forecasting-minimum	https://www.researchgate.net/publication/245281363_Forecasting_and_operational_research_A_review

PAPER 4- RELIABILITY THEORY

UNIT	TOPIC	LINK
Unit-I	Coherent Systems	https://arxiv.org/abs/1707.03173#:~:text=Reliability%20of%20components%20of%20coherent%20systems%3A%20estimates%20in%20presence%20of%20masked%20data,-Agatha%20Sacramento%20Rodrigues&text=The%20reliability%20of%20a%20system,each%20component%20of%20the%20system.
	Series and parallel systems	https://link.springer.com/chapter/10.1007/978-94-009-2776-6_4
Unit-II	Reliability of coherent systems	https://arxiv.org/abs/1707.03173#:~:text=Reliability%20of%20components%20of%20coherent%20systems%3A%20estimates%20in%20presence%20of%20masked%20data,-Agatha%20Sacramento%20Rodrigues&text=The%20reliability%20of%20a%20system,each%20component%20of%20the%20system.
Unit-III	Life Distribution	https://reliawiki.org/index.php/Life_Distributions#:~:text=We%20use%20the%20term%20life,(or%20probability%20density%20function).
Unit-IV	Reliability estimation	https://en.wikipedia.org/wiki/Reliability_(statistics)#:~:text=given%20test%20score.-,Estimation,methods%20of%20estimating%20test%20reliability.
	Availability theory	https://www.sciencedirect.com/science/article/abs/pii/S0026271485800226

PAPER 4- DATA MODELING USING MACHINE LEARNING TECHNIQUES

UNIT	TOPIC	LINK
Unit-I	Introduction to data types	https://www.simplilearn.com/what-is-data-modeling-article
	Measurement of scales	https://medium.com/analytics-vidhya/data-types-and-measurement-scales-in-machine-learning-b1697b3ba836
Unit-II	Introduction to statistical hypothesis concepts	https://www.javatpoint.com/hypothesis-in-machine-learning
	Data transformations	https://www.akkio.com/post/data-transformation-in-machine-learning#:~:text=Data%20transformation%20is%20also%20known,able%20to%20make%20accurate%20predictions.
Unit-III	Introduction to Modeling concepts	https://www.mydatamodels.com/data-modeling/
	SVM	https://towardsdatascience.com/support-vector-machine-introduction-to-machine-learning-algorithms-934a444fca47
	XG boosting	https://www.nvidia.com/en-us/glossary/data-science/xgboost/#:~:text=What%20is%20XGBoost%3F,%2C%20classification%2C%20and%20ranking%20problems.
Unit-IV	Concepts of Model evolution	https://www.javatpoint.com/machine-learning-models
	Model performance concepts for regression	https://www.seldon.io/machine-learning-regression-explained#:~:text=What%20are%20regression%20models%20used,independent%20variables%20and%20an%20outcome.

	saving models for future use	https://www.geeksforgeeks.org/saving-a-machine-learning-model/

M.Sc(Applied Statistics) : Sem-IV

Paper 1- Statistical Process and Quality Control

UNIT	TOPICS	LINK
Unit-I	Basic concept of process monitoring	https://sites.chemengr.ucsb.edu/~ceweb/faculty/seborg/teaching/SEM_2_slides/Chapter_21.pdf
	Choice of control limits	https://en.wikipedia.org/wiki/Process_Window_Index
	General theory and review of control charts for variable data and attributes	https://www.researchgate.net/publication/233918401_General_control_charts_for_variables
	nonmanufacturing applications of Statistical process control,	https://blog.kainexus.com/improvement-disciplines/lean/control-charts/the-use-of-control-charts-for-non-manufacturing-activities
Unit-II	Moving Average and exponentially weighted moving average charts,Cu-sum charts using V-Masks and decision intervals	https://math.montana.edu/jobo/st528/documents/chap9d.pdf
	Cu-sum charts using V-Masks and decision intervals	http://www.statvision.com/Userfiles/file/PDFs/cusum%20charts%20(v-mask).pdf
	Economic design of X bar chart	http://ethesis.nitrkl.ac.in/2277/1/darun_final_report12.pdf
	Concept of control chart for non-normal distributions	https://smartersolutions.com/control-chart-non-normal-distribution-process-stability-capability-assessment.html/
Unit-III	Acceptance sampling plans for attribute inspection	https://egyankosh.ac.in/bitstream/123456789/20768/1/Unit-5.pdf
	double and sequential sampling plans and their properties	https://www.shareyouressays.com/knowledge/useful-notes-on-single-double-and-sequential-sampling-plan/116355
	Rectifying sampling plans for attributes	https://www.egyankosh.ac.in/bitstream/123456789/20769/1/Unit-6.pdf
	designing of R.S.P. for specified AOQL and LTPD	https://www.researchgate.net/publication/220504703_Designing_Variables_Sampling_Plans_with_Process_Loss_Consideration
Unit-IV	Process Capability Analysis	https://www.esqe.org/Admin/Uploads/AR/202109261212406211.pdf
	Capability indices Cp	https://www.pqsystems.com/qualityadvisor/DataAnalysisTools/capability_cp.php
	Cpk and Cpm	https://www.qualitygurus.com/process-capability-and-performance-cp-cpk-pp-ppk-cpm/
	Multivariate quality control	http://www.opf.slu.cz/vvr/akce/turecko/pdf/Firat.pdf

Paper 2- Applied Stochastic Processes

UNIT	TOPICS	LINK
Unit-I	Markov Chains,	http://www.statslab.cam.ac.uk/~rrw1/markov/M.pdf
	Classification of states	https://unacademy.com/content/railway-exam/study-material/polity/states-classification/
	canonical representation of transition probability matrix	https://www.sciencedirect.com/topics/mathematics/transition-probability-matrix
	Probabilities of absorption and mean times for absorption of the Markov Chain from transient states into recurrent classes.	https://www.probabilitycourse.com/chapter11/11_2_5_using_the_law_of_total_probability_with_recursion.php
Unit-II	Continuous–time Markov Processes	https://www.math.ucla.edu/~tml/liggett_first24.pdf
	Kolmogorov–Feller differential equations	https://www.researchgate.net/publication/307867116_On_exact_solutions_to_the_Kolmogorov-Feller_equation
	Statement of elementary and basic renewal theorems.	https://www.randomservices.org/random/renewal/LimitTheorems.html
	Branching Processes	https://en.wikipedia.org/wiki/Branching_process
Unit-III	Stochastic Processes in Biological Sciences	https://www.uu.nl/sites/default/files/20190503stochasticprocessesinbiology.pdf
	Markov models in population genetics	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1213071/
	Stochastic Processes in communication and information systems	https://en.wikipedia.org/wiki/Stochastic_process
	Stochastic Processes in traffic–flow theory	https://www.researchgate.net/publication/233785992_A_stochastic_model_of_traffic_flow_Theoretical_foundations
Unit-IV	Stochastic Processes in social and behavioural sciences	https://fau.digital.flvc.org/islandora/object/fau%3A3903/datastream/OBJ/view/Stochastic_processes_in_the_social_sciences.pdf
	Markov chain models in the study of social mobility	https://www.jstor.org/stable/2092882
	educational advancement	https://www.lawinsider.com/dictionary/educational-advancement
	Stochastic Processes in Business Management	https://www.referenceforbusiness.com/encyclopedia/Sel-Str/Stochastic-Processes.html

Paper 3- Operations Research

UNIT	TOPICS	LINK
Unit-I	Non-linear Programming problem	https://web.mit.edu/15.053/www/AMP-Chapter-13.pdf
	Formulation Generalised Lagrange multiplier technique	https://en.wikipedia.org/wiki/Lagrange_multiplier
	Kuhn-Tucker necessary and sufficient conditions for optimality of an NLPP	http://www.u.arizona.edu/~mwalker/MathCamp2021/NLP&KuhnTucker.pdf

	Wolfe's and Beale's Algorithms for solving QPP	https://ir.library.oregonstate.edu/downloads/9306t2350
Unit-II	Dynamic Programming	http://web.mit.edu/15.053/www/AMP-Chapter-11.pdf
	Principle of optimality	https://www.thoughtco.com/principle-of-optimality-definition-1147078
	solution of LPP by Dynamic Programming technique	http://www.universalteacherpublications.com/univ/ebooks/or/Ch12/dynlp.htm
	Knapsack problem by Dynamic Programming Technique	https://codecrucks.com/knapsack-problem-using-dynamic-programming/
Unit-III	Game Theory	https://kanchiuniv.ac.in/coursematerials/Game%20theory.pdf
	2 person zero sum game	https://nordstromjf.github.io/IntroGameTheory/S_IntroZeroSum.html
	pure strategies with saddle point	https://www.wisdomjobs.com/e-university/quantitative-techniques-for-management-tutorial-297/pure-strategies-game-with-saddle-point-10174.html
	mixed strategies with saddle point	https://www.uobabylon.edu.iq/eprints/publication_5_13656_31.pdf
Unit-IV	s-S policy for inventory and its derivation in the case of exponential demand	https://www.scirp.org/journal/paperinformation.aspx?paperid=63089
	Models with variable supply and models for perishable Items	https://www.hindawi.com/journals/mpe/2021/6630938/
	block and age replacement policies	https://www.sciencedirect.com/science/article/pii/S0307904X16300105
	replacement of items with long life	https://www.uotechnology.edu.iq/dep-production/branch3e_files/11r.pdf

Paper 4- Artificial Neural Networks (ANN)

UNIT	TOPICS	LINK
Unit-I	Basics of Artificial Neural Networks (ANN),	https://sist.sathyabama.ac.in/sist_coursematerial/uploads/SEC1609.pdf
	Human vs Computers	https://informationq.com/human-vs-computer/
	Un-supervised and Reinforcement learning	https://intellipaat.com/blog/supervised-learning-vs-unsupervised-learning-vs-reinforcement-learning/#:~:text=And%2C%20unsupervised%20learning%20is%20where,trial%2Dand%2Derror%20method.
	Historical Developments of ANN	https://en.wikipedia.org/wiki/History_of_artificial_neural_networks#:~:text=The%20history%20of%20artificial%20neural,to%20split%20into%20two%20approaches.
Unit-II	Perceptron Learning Algorithm	https://www.cse.iitb.ac.in/~shivaram/teaching/old/cs344+386-s2017/resources/classnote-1.pdf
	Derivation	https://www.merriam-webster.com/dictionary/derivation
	Perceptron convergence theorem (statement)	https://www.ques10.com/p/54871/explain-perceptron-convergence-theorem/

	Applications of the Perceptron learning	https://www.javatpoint.com/perceptron-in-machine-learning
Unit-III	Radial Basis Function Networks	https://www.cs.bham.ac.uk/~jxb/NN/l12.pdf
	Regularization Networks	https://cedar.buffalo.edu/~srihari/CSE574/Chap5/Chap5.5-Regularization.pdf
	Regularization theory	https://en.wikipedia.org/wiki/Regularization_(mathematics)
	Comparison with Multi-layer Perceptron	https://www.geeksforgeeks.org/difference-between-multilayer-perceptron-and-linear-regression/
Unit-IV	Boltzman Machine and its learning rule	https://www.cs.toronto.edu/~hinton/csc321/readings/boltz321.pdf
	Hopfield model and its learning	https://cedar.buffalo.edu/~srihari/CSE574/Chap5/Chap5.5-Regularization.pdf
	Stochastic machines	https://machinelearningmastery.com/stochastic-in-machine-learning/
	Sigmoid belief network learning procedure	http://proceedings.mlr.press/v38/gan15.pdf

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Paper 1- Descriptive Statistics and Probability

UNIT	TOPIC	LINK
UNIT-I Descriptive Statistics	primary and secondary data	https://www.statisticshowto.com/experimental-design/primary-data-secondary/
	Classification of data	https://byjus.com/commerce/meaning-and-objectives-of-classification-of-data/
	measures of dispersion	https://byjus.com/maths/dispersion/
	central and non-central moments	https://en.wikipedia.org/wiki/Central_moment
	Measures of skewness	https://www.scribbr.com/statistics/skewness/
UNIT-II Probability	Basic concepts of probability	https://byjus.com/maths/probability/

	mutually exclusive and exhaustive events	https://byjus.com/maths/exhaustive-events/
	Conditional probability	https://byjus.com/maths/conditional-probability/
	Boole's inequality and Bayes' theorem	https://en.wikipedia.org/wiki/Boole%27s_inequality
UNIT-III Random Variables	random variable	https://www.investopedia.com/terms/r/random-variable.asp
	Distribution function and its properties	https://www.statlect.com/glossary/distribution-function
	marginal and conditional distributions	https://www.kristakingmath.com/blog/joint-distributions
UNIT-IV Mathematical Expectation	Raw and central moments	https://www.geeksforgeeks.org/ml-raw-and-central-moments/
	Chebyshev's and Cauchy-Schwartz's inequalities	https://math.stackexchange.com/questions/3797373/does-cauchy-schwarz-inequality-contradict-chebyshevs-inequality
	moment generating function (m.g.f)	https://en.wikipedia.org/wiki/Moment-generating_function
	probability generating function (p.g.f)	https://en.wikipedia.org/wiki/Probability-generating_function

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Paper 2- Probability Distribution

UNIT	TOPIC	LINK
UNIT-I Discrete distributions-I	Uniform and Bernoulli distributions	https://en.wikipedia.org/wiki/Bernoulli_distribution
	Poisson distribution, properties of these distributions	https://www.scribbr.com/statistics/poisson-distribution/

	Poisson approximation to Binomial distribution.	vhttps://vrcacademy.com/tutorials/poisson-approximation-binomial-distribution/
	probability mass functions of Binomial distribution,	https://online.stat.psu.edu/stat414/lesson/10/10.1
	median, mode, m.g.f, c.g.f., p.g.f., c.f.	https://web.ma.utexas.edu/users/gordanz/notes/mgf_color.pdf
UNIT-II Discrete distributions-II	Negative binomial, Geometric distributions	https://online.stat.psu.edu/stat414/book/export/html/679
	Poisson approximation to Negative binomial distribution.	https://modelassist.epixanalytics.com/display/EA/Approximations+to+the+Negative+Binomial+distribution
	Hyper-geometric distribution	https://en.wikipedia.org/wiki/Hypergeometric_distribution
	Binomial approximation to Hyper-geometric distribution	https://stats.stackexchange.com/questions/360127/binomial-approximation-to-hypergeometric-probability
UNIT-III Continuous distributions-I	Normal distributions	https://en.wikipedia.org/wiki/Normal_distribution
	reproductive property	https://onlinelibrary.wiley.com/doi/10.1002/0471667196.ess2257.pub2
	Normal distribution as a limiting case of Binomial and Poisson distributions.	https://math.stackexchange.com/questions/2280760/poisson-as-limit-of-binomial-distribution
UNIT-IV Continuous distributions-II	Rectangular, Exponential	http://www.learningaboutelectronics.com/Articles/Rectangular-to-exponential-form-conversion-calculator.php
	Gamma distributions	https://en.wikipedia.org/wiki/Gamma_distribution
	reproductive property	https://www.probabilitycourse.com/chapter4/4_2_4_Gamma_distribution.php
	Beta distribution of two kinds	https://en.wikipedia.org/wiki/Beta_distribution

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Paper 3- Statistical Methods and Theory of Estimation

UNIT	TOPIC	LINK
UNIT-I	Bivariate data, Scattered diagram	https://pressbooks.lib.vt.edu/introstatistics/chapter/scatter-plots/
	Karl-Pearson correlation coefficient	https://en.wikipedia.org/wiki/Pearson_correlation_coefficient
	Simple linear regression	https://www.scribbr.com/statistics/simple-linear-regression/
UNIT-II	Concepts of partial and multiple correlation coefficients	https://en.wikipedia.org/wiki/Partial_correlation
	Association and partial association of attributes.	https://www.slideshare.net/mayankgoyal94849/association-of-attributes
	Yule's for two way data and coefficient of contingency	https://www.ucl.ac.uk/english-usage/staff/sean/resources/phimeasures.pdf
UNIT-III	Concepts of Population, Parameter, Random sample, Statistic, Sampling distribution	https://www.cliffsnotes.com/study-guides/statistics/sampling/populations-samples-parameters-and-statistics
	Exact sampling distributions - Statement and properties of c2, t and F distributions	https://en.wikipedia.org/wiki/Sampling_distribution
	Point estimation of a parameter, concept of bias and mean square error of an estimate.	https://www.math.arizona.edu/~jwatkins/G2_bias.pdf
UNIT-IV	Statement of Neyman's Factorization theorem,	https://online.stat.psu.edu/stat415/lesson/24/24.2
	Estimation by the method of moments, Maximum likelihood estimation (MLE),	https://online.stat.psu.edu/stat415/lesson/1/1.4
	Concept of interval estimation	https://en.wikipedia.org/wiki/Interval_estimation

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Paper 4- Statistical Inference

UNIT	TOPIC	LINK
UNIT-I	Concepts of statistical hypotheses	

		https://www.sciencedirect.com/topics/mathematics/statistical-hypothesis
	One and two tailed tests	https://en.wikipedia.org/wiki/One-_and_two-tailed_tests
	Statement and Proof of Neyman-Pearson's fundamental lemma for Randomized tests	https://online.stat.psu.edu/stat415/lesson/26/26.1
UNIT-II	Large sample tests for single sample mean	https://saylordotorg.github.io/text_introductory-statistics/s12-02-large-sample-tests-for-a-popul.html
	Fisher's Z-transformation for population correlation coefficient(s)	https://en.wikipedia.org/wiki/Fisher_transformation
	Definition of order statistics	https://en.wikipedia.org/wiki/Order_statistic
UNIT-III	goodness of fit and test for independence of attributes (rxs, 2xk and 2x2 contingency tables)	http://www2.stat.duke.edu/~fei/Teaching/stat101/Lect/lect17.pdf
	Tests of significance based on student's - t – t-test for single sample specified mean	https://researchrundowns.com/quantitative-methods/significance-testing/
	F - test for equality of population variances.	https://www.cuemath.com/data/f-test/
UNIT-IV	Non-parametric tests	https://en.wikipedia.org/wiki/Nonparametric_statistics
	Measurement scale - nominal, ordinal, interval and ratio	https://www.scribbr.com/statistics/levels-of-measurement/
	One sample runs test, sign test and Wilcoxon-signed rank tests	https://statkat.com/stat-tests/one-sample-wilcoxon-signed-rank-test.php

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Paper 5- Applied statistics-I

UNIT	TOPIC	LINK
UNIT-I	Sample Surveys	https://www.surveymonkey.com/mp/survey-question-examples/
	sampling and non-sampling errors	https://www.qualtrics.com/au/experience-management/research/sampling-errors/?rid=ip&prevsite=uk&newsite=au&geo=IN&geomatch=au
	Types of sampling: Subjective	https://www.scribbr.com/methodology/sampling-methods/
	SRSWR and SRSWOR	http://home.iitk.ac.in/~shalab/sampling/chapter2-sampling-simple-random-sampling.pdf
UNIT-II	Estimates of population mean, total, & proportion	https://www.scribbr.com/methodology/sampling-methods/
	Stratified Random Sampling with Proportional & Neyman allocation	http://www.its.caltech.edu/~zuev/teaching/2013Spring/Math408-Lecture-20-21.pdf
	Systematic sampling	https://statisticsbyjim.com/basics/systematic-sampling/
UNIT-III	Statistical Quality Control	https://www.britannica.com/topic/statistical-quality-control
	Shewhart Control chart	https://www.itl.nist.gov/div898/handbook/mpc/section2/mpc221.htm
	control charts for variables	https://www.presentationeze.com/presentations/statistical-process-control/statistical-process-control-full-details/control-chart/types-control-charts/
	control charts for attributes	https://www.pnw.edu/wp-content/uploads/2020/03/Lecture-Notes-5-7.pdf
	Time series:	https://en.wikipedia.org/wiki/Time_series
	additive multiplicative mixed models	https://itfeature.com/time-series-analysis-and-forecasting/multiplicative-and-additive-model
UNIT-IV	ANOVA one-way	https://theintactone.com/2019/03/06/brm-u5-topic-10-analysis-of-variance-one-way-and-two-way-classifications/
	ANOVA two-way	https://www.wallstreetmojo.com/two-way-anova/
	CRD	https://www.ndsu.edu/faculty/horsley/CRD.pdf
	RBD	https://gacbe.ac.in/pdf/ematerial/18BST53C-U3.pdf
	LSD	https://www.ndsu.edu/faculty/horsley/Latin_Square_(revised).pdf

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Paper 6- Applied statistics-II

UNIT	TOPIC	LINK
UNIT-I	Multivariate normal distribution	https://www.bauer.uh.edu/rsusmel/phd/sR-7.pdf
	Simple linear regression	https://online.stat.psu.edu/stat462/node/91/
	Multiple Linear Regression	https://www.investopedia.com/terms/m/mlr.asp
	Logistic regression	https://towardsdatascience.com/logistic-regression-detailed-overview-46c4da4303bc
UNIT-II	Principal component analysis	https://builtin.com/data-science/step-step-explanation-principal-component-analysis
	Factor analysis	https://www.statisticssolutions.com/free-resources/directory-of-statistical-analyses/factor-analysis/
	Cluster analysis	https://www.qualtrics.com/au/experience-management/research/cluster-analysis/
	Linear discriminant analysis	https://www.geeksforgeeks.org/ml-linear-discriminant-analysis/
	Multidimensional scaling (MDS)	https://www.statisticshowto.com/multidimensional-scaling/
UNIT-III	Operations Research	https://en.wikipedia.org/wiki/Operations_research
	Convex sets and their properties	https://www.cse.iitk.ac.in/users/rmittal/prev_course/f19/reports/2convex.pdf
	Big –M /Penalty method and two-phase simplex methods.	http://ecoursesonline.iasri.res.in/mod/page/view.php?id=2940
	Concept of duality of LPP	https://www.srividyaengg.ac.in/coursematerial/CSE/104742.pdf
	Dual Primal relationship	https://en.wikipedia.org/wiki/Duality_(optimization)
UNIT-IV	Definition of transportation problem	https://www.geeksforgeeks.org/transportation-problem-set-1-introduction/
	west corner method in operation research	https://www.geeksforgeeks.org/transportation-problem-set-2-northwest-corner-method/
	Vogel's Approximation Method (VAM)	https://link.springer.com/10.1007%2F978-1-4419-1153-7_200907
	Degeneracy in TP and resolving it	https://www.geeksforgeeks.org/transportation-problem-set-7-degeneracy-in-transportation-problem/
	Assignment problem as special case of TP and LPP	https://archive.nptel.ac.in/courses/111/102/111102012/
	Hungarian method and traveling salesman problem and its solution	https://www.researchgate.net/publication/333685405_An_Application_of_the_Hungarian_Algorithm_to_Solve_Traveling_Salesman_Problem