**UPSC IFS Statistics Syllabus**

**Paper - I**

**Probability :**

* Sample space and events
* probability measure and probability space
* random variable as a measurable function
* distribution function of a random variable
* discrete and continuous-type random variable
* probability mass function, probability density function
* vector-valued random variable
* marginal and conditional distributions
* stochastic independence of events and of random variables
* expectation and moments of a random  variable
* conditional expectation
* convergence of a sequence of random variable in distribution in probability
* pth mean and almost every where
* criteria and inter-relations
* Borel-Cantelli lemma
* Chebyshev’s and Khinchine’s weak laws of large numbers
* strong law of large numbers and Kolmogorov’s theorems
* Glivenko-Cantelli theorem
* probability generating function
* characteristic function
* inversion theorem
* Laplace transform
* related uniqueness and continuity theorems
* determination of distribution by its moments
* Linderberg and Levy forms of central limit theorem
* standard discrete and continuous probability distributions
* their interrelations and limiting cases
* simple properties of finite Markov chains

**Statistical Inference :**

* Consistency
* Unbiasedness
* Efficiency
* Sufficiency
* minimal sufficiency
* completeness
* ancillary statistic
* factorization theorem
* exponential family of distribution and its properties
* uniformly minimum variance unbiased (UMVU) estimation
* Rao-Blackwell and Lehmann- Scheffe theorems
* Cramer-Rao inequality for single and several-parameter family of distributions
* minimum variance bound estimator and its properties
* modifications and extensions of Cramer-Rao inequality
* Chapman-Robbins inequality, Bhattacharya’s bounds
* estimation by methods of moments, maximum likelihood
* least squares
* minimum chisquare
* modified minimum chi-square properties of maximum likelihood
* other estimators,
* idea of asymptotic efficiency
* idea of prior and posterior distributions
* Bayes
* estimators
* Non-randomised and randomised tests
* critical function
* MP tests
* Neyman- Pearson lemma
* UMP tests, monotone likelihood ratio
* generalised Neyman- Pearson lemma
* similar and unbiased tests
* UMPU tests for single and severalparameter families of distributions
* likelihood rotates and its large sample properties
* chi-square goodness of fit test and its asymptotic distribution.
* Confidence bounds and its relation with tests
* uniformly most accurate (UMA) and UMA unbiased confidence bounds.
* Kolmogorov’s test for goodness of fit and its consistency
* sign test and its optimality
* Wilcoxon signed-ranks test and its consistency
* Kolmogorov-Smirnov twosample test
* run test
* Wilcoxon-Mann- Whitney test and median test
* their consistency and asymptotic normality
* Wald’s SPRT and its properties
* OC and ASN functions
* Wald’s fundamental identity
* sequential estimation

**Linear Inference and Multivariate Analysis :**

* Linear statistical models
* theory of least squares and analysis of variance
* Gauss- Markoff theory
* normal equations
* least squares estimates and their precision
* test of significance and interval estimates based on least squares theory in one-way,two-way and three-way classified data
* regression analysis
* linear regression
* curvilinear regression and orthogonal polynomials
* multiple regression
* multiple and partial correlations
* regression diagnostics and sensitivity analysis
* calibration problems
* estimation of variance and covariance components
* MINQUE theory
* multivariate normal distribution
* Mahalanobis
* D2 and Hotelling’s T2 statistics and their applications and properties
* discriminant analysis
* canonical correlations
* one-way MANOVA
* principal component analysis
* elements of factor analysis

**Sampling Theory and Design of Experiments :**

* An outline of fixed-population and superpopulation approaches,
* distinctive features of finite population sampling
* probability sampling designs
* simple random sampling with and without replacement
* stratified random sampling
* systematic sampling and its efficacy for structural populations
* cluster sampling
* two-stage and multi-stage sampling
* ratio and regression
* methods of estimation involving one or more auxiliary variables
* two-phase sampling
* probability proportional to size sampling with and without replacement
* the Hansen-Hurwitz and the Horvitz-Thompson estimator
* nonnegative variance estimation with reference to the Horvitz-Thompson estimators non-sampling errors
* Warner’s randomised response technique for sensitive characteristics.
* Fixed effects model (two-way classification) random and mixed effects models (two-way classification with equal number of observation per cell), CRD, RBD, LSD and their analysis, incomplete block designs, concepts of orthogonality and balance, BIBD, missing plot technique, factorial designs: 2n, 32 and 33, confounding in factorial experiments, splitplot and simple lattice designs.

**Paper – II**

**I. Industrial Statistics:**

* Process and product control
* general theory of control charts
* different types of control charts for variables and attributes, X, R, s, p, np and c charts
* cumulative sum chart
* V-mask
* single, double, multiple and sequential sampling plans for attributes
* OC, ASN, AQQ and ATI curves
* concepts of producer’s and consumer’s risks
* AQL
* LTPD and AOQL
* sampling plans for variables
* use of Dodge-Roming and Military Standard tables
* Concepts of reliability
* maintainability and availability
* reliability of series and parallel systems and other simple configurations
* renewal density and renewal function
* survival models (exponential, Weibull, lognormal, Rayleigh, and bath-tub)
* different types of redundancy and use of redundancy in reliability improvement
* Problems in lifetesting censored and truncated experiments for exponential models.

**II. Optimization Techniques:**

* Different types of models in Operational Research
* their construction and general methods of solution
* simulation and Monte-Carlo methods
* the structure and formulation of linear programming (LP) problem
* simple LP model and its graphical solution
* the simplex procedure
* the two-phase method and the Mtechnique with artificial variables
* the duality theory of LP and its economic interpretation, sensitivity analysis, transportation and assignment problems
* rectangular games
* two-person zero- sum games
* method of solution (graphical and algebraic).
* Replacement of failing or deteriorating items
* group and individual replacement policies
* concept of scientific inventory management
* analytical structure of inventory problems
* simple models with deterministic and stochastic demand with and without lead time
* storage models with particular reference to dam type.
* Homogeneous discrete-time Markov chains
* transition probability matrix
* classification of states and ergodic theorems
* homogeneous continuoustime Markov chains
* Poisson process
* elements of queuing theory
* M/M/1, M/M/K, G/M/1 and M/G/1 queues
* Solution of statistical problems on computers using well-known statistical software packages like SPSS.

**III. Quantitative Economics and Official Statistics :**

* Determination of trend, seasonal and cyclical components,
* Box-Jenkins method
* tests for stationery of series
* ARIMA models and determination of orders of autoregressive and moving average components, forecasting.
* Commonly used index numbers
* Laspeyre’s, Paashe’s and Fisher’s ideal Index numbers
* chain-base index numbers
* uses and limitations of index number
* index number of wholesale prices
* consumer price index number
* index numbers of agricultural and industrial production
* test for index numbers like proportionality test
* timereversal test
* factor-reversal test
* circular test and dimensional invariance test
* General linear model
* ordinary least squares and generalised least squares methods of estimation
* problem of multicollinearity
* consequences and solutions of multi-collinearity
* autocorrelation and its consequences
* heteroscedasticity of disturbances and its testing
* test for independence of disturbances
* Zellner’s seemingly unrelated regression equation model and its estimation
* concept ofstructure and model for simultaneousequations
* problem of identification-rank and order conditions of identifiability
* twostageleast squares method of estimation
* Present official statistical system in India relating to population
* Agriculture
* industrial production
* trade and prices
* methods of collection of official statistics
* their reliability and limitation and the principal publications containing such statistics various official agencies responsible for data collection and their main functions.

**IV. Demography and Psychometry :**

* Demographic data from census, registration
* NSS and other surveys, and their limitation and uses
* Definition
* construction and uses of vital rates and ratios
* measures of fertility
* reproduction rates, morbidity rate
* standardized death rate
* complete and abridged life tables
* construction of life tables from vital statistics and census returns
* uses of life tables
* logistic and other population growth curve
* fitting a logistic curve
* population projection
* stable population theory
* uses of stable population
* quasi-stable population techniques in estimation of demographic parameters
* morbidity and its measurement
* standard classification by cause of death
* health surveys and use of hospital statistics.
* Method of standardisation of scales and tests
* Z-scores, standard scores
* Tscores, percentile scores
* intelligence quotient and its measurement and uses
* validity of test scores and its determination
* use of factor analysis and path analysis in psychometry