

		(c) ataxic.
OA	6.	One arm affected (Right or Left) (a) impaired reach (b) weakness of grip (c) ataxic.
BH	7.	Stiff back and hips (cannot sit or stoop)
MW	8.	Muscular Weakness and limited physical endurance
B	9.	The blind
PB/LV	10	Partially blind /Low Vision
HI	11	Hearing Impaired
D	12	The deaf
PD	13	Partially deaf

9. No request for withdrawal of candidature received from a candidate after he/she has submitted his/her application will be entertained under any circumstances.

10. Details about the scheme of examination, standard and syllabi of the subjects etc. may be seen in Appendix-I of this Notice.

( OM PRAKASH )  
Under Secretary  
Union Public Service Commission

**APPENDIX-I**  
**SCHEME OF EXAMINATION**  
**SECTION-I**

The examination shall be conducted according to the following plan—

Part I-Written examination carrying a maximum of 1000 marks in the subjects as shown below.

Part II-Viva voce of such candidates as may be called by the Commission carrying a maximum of 200 marks.

**PART-I**

The subjects of the written examination under Part-I, the maximum marks allotted to each subject/paper and the time allowed shall be as follows :

**A. Indian Economic Service**

Sl. No.	Subject	Maximum Marks	Time Allowed
1.	General English	100	3 hrs.
2.	General Studies	100	3 hrs.
3.	General Economics-I	200	3 hrs.
4.	General Economics-II	200	3 hrs.
5.	General Economics-III	200	3 hrs.
6.	Indian Economics	200	3 hrs.

**B. Indian Statistical Service**

Sl. No.	Subject	Maximum Marks	Time Allowed
1.	General English	100	3 hrs.
2.	General Studies	100	3 hrs.
3.	Statistics-I (Objective)	200	2 hrs.
4.	Statistics-II (Objective)	200	2 hrs.
5.	Statistics-III (Descriptive)	200	3 hrs.
6.	Statistics-IV (Descriptive)	200	3 hrs.

**Note-1 : Statistics I & II will be of Objective Type Questions (80 questions with maximum marks of 200 in each paper) to be attempted in 120 minutes.**

**Note-2 : Statistics III & IV will be of Descriptive Type having Short Answer/ Small Problems Questions (50%) and Long Answer and Comprehension problem questions (50%). At least one Short Answer and One Long Answer Question from each section is compulsory. In Statistics-IV, equal number of questions i.e. 50% weightage from all the sub-sections below and candidates have to choose any two sub-sections and answer.**

**Note 3 : The papers on General English and General Studies, common to both Indian Economic Service and Indian Statistical Service will be of subjective type.**

**Note 4 : All other papers of Indian Economic Service will be of subjective type.**

**Note-5 : The details of standard and syllabi for the examination are given in Section-II below.**

2. The question papers in all subjects in Indian Economic Service Examination and in Indian Statistical Service Examination will be of Conventional (essay) type except in Statistics Paper I and Statistics Paper II which are Objective Type Papers.

3. ALL QUESTION PAPERS MUST BE ANSWERED IN ENGLISH; QUESTION PAPERS WILL BE SET IN ENGLISH ONLY.

4. Candidates must write the papers in their own hand. In no circumstances will they be allowed the help of a scribe to write the answers for them. However, blind candidates and candidates with Locomotor Disability and Cerebral Palsy where dominant (writing) extremity is affected to the extent of slowing the performance of function (minimum of 40 % impairment) will be allowed to write the examination with the help of a scribe.

**Compensatory time of 20 minutes per hour for each paper will also be allowed to a blind candidate and the candidates with locomotor disability and cerebral palsy where dominant (writing) extremity is affected to the extent of slowing the performance of function (minimum of 40% impairment).**

**Note (1):** The eligibility conditions of a scribe, his/her conduct inside the examination hall and the manner in which an extent to which he/she can help the blind candidate in writing the Indian Economic Service/Indian Statistical Service Examination shall be governed by the instructions issued by the UPSC in this regard. Violation of all or any of the said instructions shall entail the cancellation of the candidature of the blind candidate in addition to any other action that the UPSC may take against the scribe.

**Note (2):** For purpose of these rules the candidate shall be deemed to be a blind candidate if the percentage of visual impairment is forty per cent (40 %) or more. However, the extent of visual impairment should have to be corroborated by a certificate in the prescribed proforma from a Medical Board constituted by the Central/State Government along with their Detailed Application Form.

**Note (3):** The concession admissible to blind candidates shall not be admissible to those suffering from Myopia.

5. The Commission have the discretion to fix qualifying marks in any or all the subjects of the examination.

6. If a candidate's handwriting is not easily legible, a deduction will be made on this account, from the total marks otherwise accruing to him/her.

7. Marks will not be allotted for mere superficial knowledge.

8. Credit will be given for orderly effective and exact expression combined with due economy of words.

9. In the question papers, wherever required, SI Units will be used.

10. Candidates will be allowed the use of Scientific (Non-Programmable type) Calculators at the examination. Programmable type calculators will, however, not be allowed and the use of such calculators shall tantamount to resorting to unfair means by the candidates. Loaning or interchanging of calculators in the Examination Hall is not permitted.

11. Candidates should use only International Form of Indian numerals (e.g., 1, 2, 3, 4, 5, 6 etc.) while answering question papers.

## **PART - II**

*Viva voce*—The candidate will be interviewed by a Board of competent and unbiased observers who will have before them a record of his/her career. The object of the interview is to assess his/her suitability for the service for which he/she has competed. The interview is intended to supplement the written examination for testing the general and specialised knowledge and abilities for the candidate. The candidate will be expected to have taken an intelligent interest not only in his/her subjects of academic study but also in events which are happening around him/her both within and outside his/her own State or Country as well as in modern currents of thought and in new discoveries which should rouse the curiosity of well educated youth.

The technique of the interview is not that of a strict cross-examination, but of a natural, through directed and purposive conversation intended to reveal the candidate's mental qualities and his/her grasp of problems. The Board will pay special attention to assess the intellectual curiosity, critical powers of assimilation, balance of judgment and alertness of mind, the ability for social cohesion, integrity of character initiative and capacity for leadership.

## **SECTION-II**

### **STANDARD AND SYLLABI**

The standard of papers in General English and General Studies will be such as may be expected of a graduate of an Indian University.

The standard of papers in the other subjects will be that of the Master's degree examination of an Indian University in the relevant disciplines. The candidates will be expected to illustrate theory by facts, and to analyse problems with the help of theory. They will be

expected to be particularly conversant with Indian problems in the field(s) of Economics/Statistics.

#### GENERAL ENGLISH

Candidates will be required to write an essay in English. Other questions will be designed to test their understanding of English and workman like use of words. Passages will usually be set for summary or precis.

#### GENERAL STUDIES

General knowledge including knowledge of current events and of such matters of everyday observation and experience in their scientific aspects as may be expected of an educated person who has not made a special study of any scientific subject. The paper will also include questions on Indian Polity including the political system and the Constitution of India, History of India and Geography of a nature which a candidate should be able to answer without special study.

#### GENERAL ECONOMICS – I

##### PART A :

**1. Theory of Consumer's Demand**—Cardinal utility Analysis: Marginal utility and demand, Consumer's surplus, Indifference curve, Analysis and utility function, Price income and substitution effects, Slutsky theorem and derivation of demand curve, Revealed preference theory. Duality and indirect utility function and expenditure function, Choice under risk and uncertainty. **Simple games of complete information, Concept of Nash equilibrium.**

**2. Theory of Production:** Factors of production and production function. Forms of Production Functions: Cobb Douglas, CES and Fixed coefficient type, Translog production function. Laws of return, Returns to scale and Return to factors of production. Duality and cost function, Measures of productive efficiency of firms, technical and allocative efficiency. Partial Equilibrium versus General Equilibrium approach. Equilibrium of the firm and industry.

**3. Theory of Value:** Pricing under different market structures, public sector pricing, marginal cost pricing, peak load pricing, cross-subsidy free pricing and average cost pricing. Marshallian and Walrasian stability analysis. Pricing with incomplete information and moral hazard problems.

**4. Theory of Distribution:** Neo classical distribution theories; Marginal productivity theory of determination of factor prices, Factor shares and adding up problems. Euler's theorem, Pricing of factors under imperfect competition, monopoly and bilateral monopoly. Macro-distribution theories of Ricardo, Marx, Kaldor, Kalecki.

**5. Welfare Economics:** Inter-personal comparison and aggression problem, Public goods and externalities, Divergence between social and private welfare, compensation principle. Pareto optimality. Social choice and other recent schools, including Coase and Sen.

##### PART B : Quantitative Methods in Economics

1. Mathematical Methods in Economics: Differentiation and Integration and their application in economics. Optimisation techniques, Sets, Matrices and their application in economics. Linear algebra and Linear programming in economics and Input-output model of Leontief.

2. Statistical and Econometric Methods: Measures of central tendency and dispersions, Correlation and Regression. Time series. Index numbers. Sampling of curves based on various linear and non-linear function. Least square methods and other multivariate analysis (only concepts and interpretation of results). Analysis of Variance, Factor analysis, Principle component analysis, Discriminant analysis. Income distribution: Pareto law of Distribution, longnormal distribution, measurement of income inequality. Lorenz curve and Gini coefficient.

**Univariate and multivariate regression analysis. Problems and remedies of Heteroscedasticity, Autocorrelation and Multicollinearity.**

#### GENERAL ECONOMICS – II

**1. Economic Thought:** Mercantilism Physiocrats, Classical, Marxist, Neo-classical, Keynesian and Monetarist schools of thought.

**2. Concept of National Income and Social Accounting:** Measurement of National Income, Inter relationship between three measures of national income in the presence of Government sector and International transactions. Environmental considerations, Green national income.

**3. Theory of employment, Output, Inflation, Money and Finance:** The Classical theory of Employment and Output and Neo classical approaches. Equilibrium, analysis under classical and neo classical analysis. Keynesian theory of Employment and output. Post Keynesian developments. The inflationary gap; Demand pull versus cost push inflation, the Philip's curve and its policy implication. Classical theory of Money, Quantity theory of Money. Friedman's restatement of the quantity theory, the neutrality of money. The supply and demand for

loanable funds and equilibrium in financial markets, Keynes' theory on demand for money. **IS-LM Model and AD-AS Model in Keynesian Theory.**

**4. Financial and Capital Market:** Finance and economic development, financial markets, stock market, gift market, banking and insurance. Equity markets, Role of primary and secondary markets and efficiency, Derivatives markets; Future and options.

**5. Economic Growth and Development:** concepts of Economic Growth and Development and their measurement: characteristics of less developed countries and obstacles to their development – growth, poverty and income distribution. Theories of growth: Classical Approach: Adam Smith, Marx and Schumpeter- Neo classical approach; Robinson, Solow, Kaldor and Harrod Domar. Theories of Economic Development, Rostow, Rosenstein-Rodan, Nurske, Hirschman, Leibenstein and Arthur Lewis, Amin and Frank (Dependency school) respective role of state and the market. Utilitarian and Welfarist approach to social development and A.K. Sen's critique. Sen's capability approach to economic development. The Human Development Index. Physical quality of Life Index and Human Poverty Index. **Basics of Endogenous Growth Theory.**

**6. International Economics:** Gains from International Trade, Terms of Trade, policy, international trade and economic development- Theories of International Trade; Ricardo, Haberler, Heckscher- Ohlin and Stolper- Samuelson- Theory of Tariffs- Regional Trade Arrangements. **Asian Financial Crisis of 1997, Global Financial Crisis of 2008 and Euro Zone Crisis- Causes and Impact.**

**7. Balance of Payments:** Disequilibrium in Balance of Payments, Mechanism of Adjustments, Foreign Trade Multiplier, Exchange Rates, Import and Exchange Controls and Multiple Exchange Rates. **IS-LM Model and Mundell- Fleming Model of Balance of Payments.**

**8. Global Institutions:** UN agencies dealing with economic aspects, **role of Multilateral Development Bodies (MDBs), such as World Bank, IMF and WTO, Multinational Corporations. G-20.**

### GENERAL ECONOMICS – III

**1. Public Finance**—Theories of taxation: Optimal taxes and tax reforms, incidence of taxation. Theories of public expenditure: objectives and effects of public expenditure, public expenditure policy and social cost benefit analysis, criteria of public investment decisions, social rate of discount, shadow prices of investment, unskilled labour and foreign exchange. Budgetary deficits. Theory of public debt management.

**2. Environmental Economics**—Environmentally sustainable development, **Rio process 1992 to 2012**, Green GDP, UN Methodology of Integrated Environmental and Economic Accounting. Environmental Values: Users and non-users values, option value. Valuation Methods : Stated and revealed preference methods. Design of Environmental Policy Instruments: Pollution taxes and pollution permits, collective action and informal regulation by local communities. Theories of exhaustible and renewable resources. International environmental agreements, **RIO Conventions**. Climatic change problems. Kyoto protocol, **UNFCC, Bali Action Plan, Agreements upto 2016**, tradable permits and carbon taxes. **Carbon Markets and Market Mechanisms. Climate Change Finance and Green Climate Fund.**

**3. Industrial Economics**—Market structure, conduct and performance of firms, product differentiation and market concentration, monopolistic price theory and oligopolistic interdependence and pricing, entry preventing pricing, micro level investment decisions and the behaviour of firms, research and development and innovation, market structure and profitability, public policy and development of firms.

**4. State, Market and Planning**—Planning in a developing economy. Planning regulation and market. Indicative planning. Decentralised planning.

### INDIAN ECONOMICS

**1. History of development and planning**— Alternative development strategies—goal of self-reliance based on import substitution and protection, the post-1991 globalisation strategies based on stabilisation and structural adjustment packages: fiscal reforms, financial sector reforms and trade reforms.

**2. Federal Finance**—Constitutional provisions relating to fiscal and financial powers of the States, Finance Commissions and their formulae for sharing taxes, Financial aspect of Sarkaria Commission Report, financial aspects of 73rd and 74th Constitutional Amendments.

**3. Budgeting and Fiscal Policy**—Tax, expenditure, budgetary deficits, pension and fiscal reforms, Public debt management and reforms, Fiscal Responsibility and Budget Management (FRBM) Act, Black money and Parallel economy in India—definition, estimates, genesis, consequences and remedies.

**4. Poverty, Unemployment and Human Development**—Estimates of inequality and poverty measures for India, appraisal of Government measures, India's human development record in global perspective. India's population policy and development.

**5. Agriculture and Rural Development Strategies**— Technologies and institutions, land relations and land reforms, rural credit, modern farm inputs and marketing— price policy and subsidies; commercialisation and diversification. Rural development programmes including poverty alleviation programmes, development of economic and social infrastructure and New Rural Employment Guarantee Scheme.

**6. India's experience with Urbanisation and Migration**—Different types of migratory flows and their impact on the economies of their origin and destination, the process of growth of urban settlements; urban development strategies.

**7. Industry: Strategy of industrial development**— Industrial Policy Reform; Reservation Policy relating to small scale industries. Competition policy, Sources of industrial finances. Bank, share market, insurance companies, pension funds, non-banking sources and foreign direct investment, role of foreign capital for direct investment and portfolio investment, Public sector reform, privatisation and disinvestment.

**8. Labour**—Employment, unemployment and underemployment, industrial relations and labour welfare— strategies for employment generation—Urban labour market and informal sector employment, Report of National Commission on Labour, Social issues relating to labour e.g. Child Labour, Bonded Labour International Labour Standard and its impact.

**9. Foreign trade**—Salient features of India's foreign trade, composition, direction and organisation of trade, recent changes in trade, balance of payments, tariff policy, exchange rate, India and WTO requirements. **Bilateral Trade Agreements and their implications.**

**10. Money and Banking**—Financial sector reforms, Organisation of India's money market, changing roles of the Reserve Bank of India, commercial banks, development finance institutions, foreign banks and non-banking financial institutions, Indian capital market and SEBI, Development in Global Financial Market and its relationship with Indian Financial Sector. **Commodity Market in India-Spot and Futures Market, Role of FMC.**

**10. Inflation**—Definition, trends, estimates, consequences and remedies (control): Wholesale Price Index. Consumer Price Index: components and trends.

#### STATISTICS-I (OBJECTIVE TYPE)

**(i) Probability:**

Classical and axiomatic definitions of Probability and consequences. Law of total probability, Conditional probability, Bayes' theorem and applications. Discrete and continuous random variables. Distribution functions and their properties.

Standard discrete and continuous probability distributions - Bernoulli, Uniform, Binomial, Poisson, Geometric, Rectangular, Exponential, Normal, Cauchy, Hyper geometric, Multinomial, Laplace, Negative binomial, Beta, Gamma, Lognormal. Random vectors, Joint and marginal distributions, conditional distributions, Distributions of functions of random variables. Modes of convergences of sequences of random variables - in distribution, in probability, with probability one and in mean square. Mathematical expectation and conditional expectation. Characteristic function, moment and probability generating functions, Inversion, uniqueness and continuity theorems. Borel 0-1 law, Kolmogorov's 0-1 law. Tchebycheff's and Kolmogorov's inequalities. Laws of large numbers and central limit theorems for independent variables.

**(ii) Statistical Methods:**

Collection, compilation and presentation of data, charts, diagrams and histogram. Frequency distribution. Measures of location, dispersion, skewness and kurtosis. Bivariate and multivariate data. Association and contingency. Curve fitting and orthogonal polynomials. Bivariate normal distribution. Regression-linear, polynomial. Distribution of the correlation coefficient, Partial and multiple correlation, Intraclass correlation, Correlation ratio.

Standard errors and large sample test. Sampling distributions of sample mean, sample variance,  $t$ , chi-square and  $F$ ; tests of significance based on them, Small sample tests.

Non-parametric tests-Goodness of fit, sign, median, run, Wilcoxon, Mann-Whitney, Wald-Wolfowitz and Kolmogorov-Smirnov. Order statistics-minimum, maximum, range and median. Concept of Asymptotic relative efficiency.

**(iii) Numerical Analysis:**

**Finite differences of different orders:**  $\Delta$ ,  $E$  and  $D$  operators, factorial representation of a polynomial, separation of symbols, sub-division of intervals, differences of zero.

**Concept of interpolation and extrapolation:** Newton Gregory's forward and backward interpolation formulae for equal intervals, divided differences and their properties, Newton's

formula for divided difference, Lagrange's formula for unequal intervals, central difference formula due to Gauss, Sterling and Bessel, concept of error terms in interpolation formula.

**Inverse interpolation:** Different methods of inverse interpolation.

**Numerical differentiation:** Trapezoidal, Simpson's one-third and three-eighth rule and Waddles rule.

**Summation of Series:** Whose general term (i) is the first difference of a function (ii) is in geometric progression.

**Numerical solutions of differential equations:** Euler's Method, Milne's Method, Picard's Method and Runge-Kutta Method.

**(iv) Computer application and Data Processing:**

**Basics of Computer:** Operations of a computer, Different units of a computer system like central processing unit, memory unit, arithmetic and logical unit, input unit, output unit etc., Hardware including different types of input, output and peripheral devices, Software, system and application software, number systems, Operating systems, packages and utilities, Low and High level languages, Compiler, Assembler, Memory – RAM, ROM, unit of computer memory (bits, bytes etc.), Network – LAN, WAN, internet, intranet, basics of computer security, virus, antivirus, firewall, spyware, malware etc.

**Basics of Programming:** Algorithm, Flowchart, Data, Information, Database, overview of different programming languages, frontend and backend of a project, variables, control structures, arrays and their usages, functions, modules, loops, conditional statements, exceptions, debugging and related concepts.

### STATISTICS- II (OBJECTIVE TYPE)

**(i) Linear Models:**

**Theory of linear estimation, Gauss-Markov linear models, estimable functions, error and estimation space, normal equations and least square estimators, estimation of error variance, estimation with correlated observations, properties of least square estimators, generalized inverse of a matrix and solution of normal equations, variances and covariances of least square estimators.**

One way and two-way classifications, fixed, random and mixed effects models. Analysis of variance (two-way classification only), multiple comparison tests due to Tukey, Scheffe and Student-Newmann-Keul-Duncan.

**(ii) Statistical Inference and Hypothesis Testing:**

**Characteristics of good estimator.** Estimation methods of maximum likelihood, minimum chi-square, moments and least squares. Optimal properties of maximum likelihood estimators. Minimum variance unbiased estimators. Minimum variance bound estimators. Cramer-Rao inequality. Bhattacharya bounds. Sufficient estimator. factorization theorem. Complete statistics. Rao-Blackwell theorem. Confidence interval estimation. Optimum confidence bounds. Resampling, Bootstrap and Jackknife.

**Hypothesis testing:** Simple and composite hypotheses. Two kinds of error. Critical region. Different types of critical regions and similar regions. Power function. Most powerful and uniformly most powerful tests. Neyman-Pearson fundamental lemma. Unbiased test. Randomized test. Likelihood ratio test. Wald's SPRT, OC and ASN functions. Elements of decision theory.

**(iii) Official Statistics:**

**National and International official statistical system**

Official Statistics: (a) Need, Uses, Users, Reliability, Relevance, Limitations, Transparency, its visibility (b) Compilation, Collection, Processing, Analysis and Dissemination, Agencies Involved, Methods

**National Statistical Organization:** Vision and Mission, NSSO and CSO; roles and responsibilities; Important activities, Publications etc.

**National Statistical Commission:** Need, Constitution, its role, functions etc; Legal Acts/ Provisions/ Support for Official Statistics; Important Acts

**Index Numbers:** Different Types, Need, Data Collection Mechanism, Periodicity, Agencies Involved, Uses

**Sector Wise Statistics:** Agriculture, Health, Education, Women and Child etc. Important Surveys & Census, Indicators, Agencies and Usages etc.

**National Accounts:** Definition, Basic Concepts; issues; the Strategy, Collection of Data and Release.

**Population Census:** Need, Data Collected, Periodicity, Methods of data collection, dissemination, Agencies involved.

**Misc:** Socio Economic Indicators, Gender Awareness/Statistics, Important Surveys and Censuses.

### **STATISTICS- III (DESCRIPTIVE TYPE)**

#### **(i) Sampling Techniques:**

Concept of population and sample, need for sampling, complete enumeration versus sampling, basic concepts in sampling, sampling and Non-sampling error, Methodologies in sample surveys (questionnaires, sampling design and methods followed in field investigation) by NSSO.

Subjective or purposive sampling, probability sampling or random sampling, simple random sampling with and without replacement, estimation of population mean, population proportions and their standard errors. Stratified random sampling, proportional and optimum allocation, comparison with simple random sampling for fixed sample size. Covariance and Variance Function.

Ratio, product and regression methods of estimation, estimation of population mean, evaluation of Bias and Variance to the first order of approximation, comparison with simple random sampling.

Systematic sampling (when population size (N) is an integer multiple of sampling size (n)). Estimation of population mean and standard error of this estimate, comparison with simple random sampling.

Sampling with probability proportional to size (with and without replacement method), Des Raj and Das estimators for  $n=2$ , Horvitz-Thomson's estimator

Equal size cluster sampling: estimators of population mean and total and their standard errors, comparison of cluster sampling with SRS in terms of intra-class correlation coefficient.

Concept of multistage sampling and its application, two-stage sampling with equal number of second stage units, estimation of population mean and total. Double sampling in ratio and regression methods of estimation.

Concept of Interpenetrating sub-sampling.

#### **(ii) Econometrics:**

Nature of econometrics, the general linear model (GLM) and its extensions, ordinary least squares (OLS) estimation and prediction, generalized least squares (GLS) estimation and prediction, heteroscedastic disturbances, pure and mixed estimation.

Auto correlation, its consequences and tests. Theil BLUS procedure, estimation and prediction, multi-collinearity problem, its implications and tools for handling the problem, ridge regression.

Linear regression and stochastic regression, instrumental variable estimation, errors in variables, autoregressive linear regression, lagged variables, distributed lag models, estimation of lags by OLS method, Koyck's geometric lag model.

Simultaneous linear equations model and its generalization, identification problem, restrictions on structural parameters, rank and order conditions.

Estimation in simultaneous equations model, recursive systems, 2 SLS estimators, limited information estimators, k-class estimators, 3 SLS estimator, full information maximum likelihood method, prediction and simultaneous confidence intervals.

#### **(iii) Applied Statistics:**

Index Numbers: Price relatives and quantity or volume relatives, Link and chain relatives composition of index numbers; Laspeyre's, Paasches', Marshal Edgeworth and Fisher index numbers; chain base index number, tests for index number, Construction of index numbers of wholesale and consumer prices, Income distribution-Pareto and Engel curves, Concentration curve, Methods of estimating national income, Inter-sectoral flows, Inter-industry table, Role of CSO. Demand Analysis

Time Series Analysis: Economic time series, different components, illustration, additive and multiplicative models, determination of trend, seasonal and cyclical fluctuations.

Time-series as discrete parameter stochastic process, auto covariance and autocorrelation functions and their properties.

Exploratory time Series analysis, tests for trend and seasonality, exponential and moving average smoothing. Holt and Winters smoothing, forecasting based on smoothing.

Detailed study of the stationary processes: (1) moving average (MA), (2) auto regressive (AR), (3) ARMA and (4) AR integrated MA (ARIMA) models. Box-Jenkins models, choice of AR and MA periods.

Discussion (without proof) of estimation of mean, auto covariance and autocorrelation functions under large sample theory, estimation of ARIMA model parameters.

Spectral analysis of weakly stationary process, periodogram and correlogram analyses, computations based on Fourier transform.

## STATISTICS-IV (DESCRIPTIVE TYPE)

### (i) Operations Research and Reliability:

Definition and Scope of Operations Research: phases in Operation Research, models and their solutions, decision-making under uncertainty and risk, use of different criteria, sensitivity analysis.

Transportation and assignment problems. Bellman's principle of optimality, general formulation, computational methods and application of dynamic programming to LPP.

Decision-making in the face of competition, two-person games, pure and mixed strategies, existence of solution and uniqueness of value in zero-sum games, finding solutions in  $2 \times 2$ ,  $2 \times m$  and  $m \times n$  games.

Analytical structure of inventory problems, EOQ formula of Harris, its sensitivity analysis and extensions allowing quantity discounts and shortages. Multi-item inventory subject to constraints. Models with random demand, the static risk model. P and Q- systems with constant and random lead times.

Queuing models – specification and effectiveness measures. Steady-state solutions of M/M/1 and M/M/c models with associated distributions of queue-length and waiting time. M/G/1 queue and Pollazcek-Khinchine result.

Sequencing and scheduling problems. 2-machine n-job and 3-machine n-job problems with identical machine sequence for all jobs

Branch and Bound method for solving travelling salesman problem.

Replacement problems – Block and age replacement policies.

PERT and CPM – basic concepts. Probability of project completion.

Reliability concepts and measures, components and systems, coherent systems, reliability of coherent systems.

Life-distributions, reliability function, hazard rate, common univariate life distributions – exponential, weibull, gamma, etc. Bivariate exponential distributions. Estimation of parameters and tests in these models.

Notions of aging – IFR, IFRA, NBU, DMRL and NBUE classes and their duals. Loss of memory property of the exponential distribution.

Reliability estimation based on failure times in variously censored life-tests and in tests with replacement of failed items. Stress-strength reliability and its estimation.

### (ii) Demography and Vital Statistics:

Sources of demographic data, census, registration, ad-hoc surveys, Hospital records, Demographic profiles of the Indian Census.

Complete life table and its main features, Uses of life table. Makehams and Gompertz curves. National life tables. UN model life tables. Abridged life tables. Stable and stationary populations.

Measurement of Fertility: Crude birth rate, General fertility rate, Age specific birth rate, Total fertility rate, Gross reproduction rate, Net reproduction rate.

Measurement of Mortality: Crude death rate, Standardized death rates, Age-specific death rates, Infant Mortality rate, Death rate by cause.

Internal migration and its measurement, migration models, concept of international migration.

Net migration. International and postcensal estimates. Projection method including logistic curve fitting. Decennial population census in India.

### (iii) Survival Analysis and Clinical Trial:

Concept of time, order and random censoring, likelihood in the distributions – exponential, gamma, Weibull, lognormal, Pareto, Linear failure rate, inference for these distribution.

Life tables, failure rate, mean residual life and their elementary classes and their properties.

Estimation of survival function – actuarial estimator, Kaplan – Meier estimator, estimation under the assumption of IFR/DFR, tests of exponentiality against non-parametric classes, total time on test.

Two sample problem – Gehan test, log rank test.

Semi-parametric regression for failure rate – Cox's proportional hazards model with one and several covariates, rank test for the regression coefficient.

Competing risk model, parametric and non-parametric inference for this model.

Introduction to clinical trials: the need and ethics of clinical trials, bias and random error in clinical studies, conduct of clinical trials, overview of Phase I – IV trials, multicenter trials.

Data management: data definitions, case report forms, database design, data collection systems for good clinical practice.

Design of clinical trials: parallel vs. cross-over designs, cross-sectional vs. longitudinal designs, review of factorial designs, objectives and endpoints of clinical trials, design of Phase I trials,



design of single-stage and multi-stage Phase II trials, design and monitoring of phase III trials with sequential stopping,

Reporting and analysis: analysis of categorical outcomes from Phase I – III trials, analysis of survival data from clinical trials.

**(iv) Quality Control:**

Statistical process and product control: Quality of a product, need for quality control, basic concept of process control, process capability and product control, general theory of control charts, causes of variation in quality, control limits, sub grouping summary of out of control

criteria, charts for attributes p chart, np chart, c-chart, V chart, charts for variables:  $\bar{X}$ , R,  $(\bar{X}, R)$ ,  $(\bar{X}, \sigma)$  charts.

Basic concepts of process monitoring and control; process capability and process optimization. General theory and review of control charts for attribute and variable data; O.C. and A.R.L. of control charts; control by gauging; moving average and exponentially weighted moving average charts; Cu-Sum charts using V-masks and decision intervals; Economic design of X-bar chart.

Acceptance sampling plans for attributes inspection; single and double sampling plans and their properties; plans for inspection by variables for one-sided and two sided specification.

**(v) Multivariate Analysis:**

Multivariate normal distribution and its properties. Random sampling from multivariate normal distribution. Maximum likelihood estimators of parameters, distribution of sample mean vector.

Wishart matrix – its distribution and properties, distribution of sample generalized variance, null and non-null distribution of multiple correlation coefficients.

Hotelling's  $T^2$  and its sampling distribution, application in test on mean vector for one and more multivariate normal population and also on equality of components of a mean vector in multivariate normal population.

Classification problem: Standards of good classification, procedure of classification based on multivariate normal distributions.

Principal components, dimension reduction, canonical variates and canonical correlation – definition, use, estimation and computation.

**(vi) Design and Analysis of Experiments:**

Analysis of variance for one way and two way classifications, Need for design of experiments, basic principle of experimental design (randomization, replication and local control), complete analysis and layout of completely randomized design, randomized block design and Latin square design, Missing plot technique. Split Plot Design and Strip Plot Design.

Factorial experiments and confounding in  $2^n$  and  $3^n$  experiments. Analysis of covariance. Analysis of non-orthogonal data. Analysis of missing data.

**(vii) Computing with C and R :**

Basics of C: Components of C language, structure of a C program, Data type, basic data types, Enumerated data types, Derived data types, variable declaration, Local, Global, Parametric variables, Assignment of Variables, Numeric, Character, Real and String constants, Arithmetic, Relation and Logical operators, Assignment operators, Increment and decrement operators, conditional operators, Bitwise operators, Type modifiers and expressions, writing and interpreting expressions, using expressions in statements. Basic input/output.

Control statements: conditional statements, if - else, nesting of if - else, else if ladder, switch statements, loops in c, for, while, do - while loops, break, continue, exit ( ), goto and label declarations, One dimensional two dimensional and multidimensional arrays. Storage classes: Automatic variables, External variables, Static variables, Scope and lifetime of declarations.

Functions: classification of functions, functions definition and declaration, assessing a function, return statement, parameter passing in functions. Pointers (concept only).

Structure: Definition and declaration; structure (initialization) comparison of structure variable; Array of structures : array within structures, structures within structures, passing structures to functions; Unions accessing a union member, union of structure, initialization of a union variable, uses of union. Introduction to linked list, linear linked list, insertion of a node in list, removal of a node from list.

Files in C: Defining and opening a file, input – output operation on a file, creating a file, reading a file.

Statistics Methods and techniques in R.

**APPENDIX-II**

**INSTRUCTIONS TO THE CANDIDATES FOR FILLING ONLINE APPLICATIONS**

Candidates are required to apply Online using the website [www.upsconline.nic.in](http://www.upsconline.nic.in)

- Salient features of the system of Online Application Form are given hereunder :
- Detailed instructions for filling up Online applications are available on the above mentioned website.
- Candidates will be required to complete the Online Application Form containing two stages viz. Part-I and Part-II as per the instructions available in the above mentioned website through drop down menus.
- The candidates are required to pay a fee of Rs.200/- (Rupees Two Hundred only) [excepting SC/ST/Female/Physically Handicapped candidates who are exempted from payment of fee] either by depositing the money in any branch of SBI by cash, or by using net banking facility of State Bank of India/State Bank of Bikaner & Jaipur/State Bank of Hyderabad/State Bank of Mysore/State Bank of Patiala/State Bank of Travancore or by using any Visa/Master Credit/Debit Card.
- Before start filling up of Online Application, a candidate must have his/her photograph and signature duly scanned in the .jpg format in such a manner that each file should not exceed 40 KB and must not less than 3 KB in size for the photograph and 1 KB for the signature.
- The Online applications (Part I and II) can be filled from **8<sup>th</sup> February, 2017 to 03<sup>rd</sup> March, 2017 till 18.00 Hours.**
- Applicants should avoid submitting multiple applications. However, if due to any unavoidable circumstances, any applicant submits multiple applications then he/ she must ensure that the applications with higher RID is complete in all respects.
- In case of multiple applications, the applications with higher RID shall be entertained by the Commission and fee paid against one RID shall not be adjusted against any other RID.
- The applicants must ensure that while filling their Application Form, they are providing their valid and active E-Mail IDs as the Commission may use electronic mode of communication while contacting them at different stages of examination process.
- The applicants are advised to check their emails at regular intervals and ensure that the e-mail address ending with [@nic.in](mailto:@nic.in) are directed to their inbox folder and not to the SPAM folder or any other folder.
- **Candidates are strongly advised to apply online well in time without waiting for the last date for submission of Online Applications.**

#### APPENDIX III

#### Special instructions to Candidates for Conventional Type papers

##### 1. Articles permitted inside Examination Hall

Battery-operated pocket calculators of “non-programmable” type only, mathematical/engineering/drawing instruments, including a flat rule divided on the edges into inches and tens of an inch and into centimeters and millimeters, a slide rule, set squares, a protractors and a pair of compasses, coloured pencils, mapping pens, eraser, T-square and drawing board for use wherever necessary. Candidates are not allowed to bring with them any “Tables or Charts” for use in the Examination Hall.

Mobile phones, bluetooth or any other communication devices are not allowed inside the premises where the examination is being conducted. Any infringement of these instructions shall entail disciplinary action including ban from future examinations.

Candidates are advised in their own interest not to bring any of the banned items including mobile phones/Bluetooth to the venue of the examination, as arrangements for safekeeping cannot be assured.

##### 2. Tables to be supplied by UPSC

If it is considered necessary for answering the questions set in any paper, the Commission may supply any of the following for reference purpose only :-

- (i) Mathematical/Physical, Chemical and Engineering Tables (including Logarithmic Tables);
- (ii) Steam Table (including Mollier Diagrams for Temperature up to 800°C and Pressure up to 500 Kgf/Cm);
- (iii) National Building Code of India 1970 or 1983 Group 2 Part VI;
- (iv) Any other special articles as may be necessary for the candidates to answer the questions set in the question paper.

After conclusion of the examination, return the above items to the invigilator.

### 3. Answers to be written in own hand

Write the answers in your own hand in ink. Pencil may be used for maps, mathematical drawings or rough work.

### 4. Check Answer Book

The candidate must write his/her roll number (and not his/her name) only in the space provided for the purpose on every answer book used by him/her. Before writing in the answer book, please see that it is complete. In case there are any missing pages, it should be got replaced.

Do not tear out any pages from the Answer Book. If you use more than one Answer Book, indicate on the cover of first Answer Book the total number of Answer Books used. Do not leave any blank, unused spaces between answers. If such spaces are left, score them out.

### 5. Answers in excess of prescribed number will be ignored

The candidate must attempt questions strictly in accordance with the directions given on each question paper. If questions are attempted in excess of the prescribed number shall be valued and the remaining answers will be ignored.

6. Questions relating to graph/précis should be attempted only on graph/précis sheets to be supplied on demand by the invigilators. All loose sheets such as précis sheet, drawing papers, graph sheets etc. whether used or not, should be placed inside the answer books and fastened along with the additional answer book(s), if any. Candidates who fail to observe this instruction will be penalised. Do not write your roll number on these sheets.

### 7. Unfair means strictly prohibited

Do not copy from the papers of any other candidates nor allow your papers to be copied nor give nor attempt to give nor obtain nor attempt to obtain irregular assistance of any description. It will be responsibility of every candidate to ensure that his/her answers are not copied by another candidate. Failure to do so will invite penalty, as may be awarded by the Commission for adoption of unfair means.

### 8. Conduct in Examination Hall

Do not misbehave in any manner or create disorderly scene in the examination hall or harass or bodily harm the staff deployed for the conduct of examination. You will be severely penalized if you attempt to do so.

9. Please read carefully and abide by the instructions printed on the Question Paper and on the Answer Book supplied in the Examination Hall.

## APPENDIX-IV

### Special Instruction to candidates for objective type tests

1. Articles permitted inside Examination Hall  
Clip board or hard board (on which nothing is written), a good quality black ball pen for making responses on the Answer Sheet. Answer Sheet and sheet for rough work will be supplied by the invigilator.
2. Articles not permitted inside Examination Hall  
Do not bring into the Examination Hall any article other than those specified above e.g. books, notes, loose sheets, electronic or any other type of calculators, mathematical and drawing instruments, Log Tables, stencils of maps, slide rules, Test Booklets, rough sheets pertaining to earlier session(s), etc.  
**Mobile phones, bluetooth or any other communication devices are not allowed inside the premises where the examination is being conducted. Any infringement of these instructions shall entail disciplinary action including ban from future examinations. Candidates are advised in their own interest not to bring any of the banned items including mobile phones to the venue of the examination, as arrangements for safekeeping cannot be assured.**  
Candidates are advised in their own interest not to bring any of the banned items including mobile phones/Bluetooth to the venue of the examination, as arrangements for safekeeping cannot be assured.
3. **Penalty for wrong Answers (in Objective Type Papers)**  
**THERE WILL BE PENALTY (NEGATIVE MARKING) FOR WRONG ANSWERS MARKED BY A CANDIDATE IN THE OBJECTIVE TYPE QUESTION PAPERS.**
  - (i) **There are four alternatives for the answer to every question. For each question for which a wrong answer has been given by the candidate, one third (0.33) of the marks assigned to that question will be deducted as penalty.**
  - (ii) **If a candidate gives more than one answer, it will be treated as a wrong answer even if one of the given answers happens to be correct and there will be same penalty as above for that question.**

- (iii) **If a question is left blank i.e. no answer is given by the candidate, there will be no penalty for that question.**
4. **Unfair means strictly prohibited**  
No candidates shall copy from the papers of any other candidate nor permit his papers to be copied nor give nor attempt to give not obtain nor attempt to obtain irregular assistance of any description.
5. **Conduct in Examination Hall**  
No candidates should misbehave in any manner or create disorderly scene in the Examination Hall or harass the staff employed by the Commission for the conduct of the examination. Any such misconduct will be severely penalised.
6. **Answer Sheet Particulars**
- (i) Write in black ball pen your Centre and subject followed by Test Booklet series (in bracket), subject code and roll number at the appropriate space provided on the Answer Sheet at the top. Also encode your booklet series (A, B, C or D as the case may be), subject code and roll number with black ball pen in the circles provided for the purpose in the Answer Sheet. The guidelines for writing the above particulars and encoding the above particulars are given in Annexure. In case the booklet series is not printed on the Test Booklet or Answer Sheet is unnumbered, please report immediately to the invigilator and get the Test Booklet/Answer Sheet replaced.
- (ii) Candidates should note that any omission/mistake/discrepancy in encoding/filling of details in the OMR answer sheet, especially with regard to Roll Number and Test Booklet Series Code, will render the answer sheet liable for rejection.
- (iii) Immediately after commencement of the examination please check that the Test Booklet supplied to you does not have any unprinted or torn or missing pages or items etc. If so, get it replaced by a complete Test Booklet of the same series and subject.
5. Do not write your name or anything other than the specific items of information asked for, on the Answer Sheet/Test Booklet/sheet for rough work.
8. Do not fold or mutilate or damage or put any extraneous marking in the Answer Sheet. Do not write anything on the reverse of the Answer Sheet.
9. Since the Answer Sheets will be evaluated on computerised machines, candidates should exercise due care in handling and filling up the Answer Sheets. **They should use black ball pen only to darken the circles. For writing in boxes, they should use black ball pen. Since the entries made by the candidates by darkening the circles will be taken into account while evaluating the Answer Sheet on computerised machines, they should make these entries very carefully and accurately. The candidate must mark responses in the Answer Sheet with good quality black ball pen.**
10. **Method of marking answers**  
In the "OBJECTIVE TYPE" of examination, you do not write the answers. For each question (hereinafter referred to as "Item") several suggested answers (hereinafter referred to as "Responses") are given. You have to choose one response to each item. The question paper will be in the Form of TEST BOOKLET. The booklet will contain item bearing numbers 1, 2, 3 etc. Under each item, Responses marked (a), (b), (c), (d) will be given. Your task will be to choose the correct response. If you think there is more than one correct response, then choose what you consider the best response.  
In any case, for each item you are to select only one response. If you select more than one response, your response will be considered wrong. In the Answer Sheet, Serial Nos. from 1 to 160 are printed. Against each numbers, there are circles marked (a), (b), (c) and (d). After you have read each item in the Test Booklet and decided which one of the given responses is correct or the best, you have to mark your response by completely blackening to indicate your response.  
Ink pen or pencil should not be used for blackening the circle on the Answer Sheet.  
For example, if the correct answer to item 1 is (b), then the circle containing the letter (b) is to be completely blackened with black ball pen as shown below :-  
**Example : (a) • (c) (d)**
11. **Entries in Scannable Attendance List**  
Candidates are required to fill in the relevant particulars with black ball pen only against their columns in the Scannable Attendance List as given below :-  
i) Blacken the circle (P) under the column (Present/Absent)  
ii) Blacken the relevant circle for Test Booklet Series  
iii) Write Test Booklet Serial No.  
iv) Write the Answer Sheet serial No. and also blacken the corresponding circles below  
v) Append signature in the relevant column
12. Please read and abide by the instructions on the cover of Test Booklet. If any candidate indulges in disorderly or improper conduct, he will render himself liable for disciplinary action and/or imposition of a penalty as the Commission may deem fit.

13. The candidates are not allowed to leave the Examination Hall before the expiry of prescribed time period of the examination.

### Annexure

#### How to fill in the Answer Sheet of objective type tests in the Examination Hall

Please follow these instructions very carefully. You may note that since the Answer Sheets are to be evaluated on machine, any violation of these instructions may result in reduction of your score for which you would yourself be responsible.

Before you mark your responses on the Answer Sheet, you will have to fill in various particulars in it.

As soon as the candidate receives the Answer Sheet, he/she should check that it is numbered at the bottom. If it is found unnumbered he/she should at once get it replaced by a numbered one!

You will see from the Answer Sheet that you will have to fill in the top line, which reads thus:

केंद्र ----- Centre	विषय ----- Subject	विषय कोड ----- S. Code	<input type="text"/>	अनक्रमांक ----- Roll Number	<input type="text"/>
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If you are, say, appearing for the examination in Delhi Centre for the General Studies Paper and your Roll No. is 081276 and your Test Booklet series is 'A', you should fill in thus, using ball pen.

\* This is just illustrative and may not be relevant to the Examination concerned.

केंद्र ----- Centre DELHI	विषय ----- Subject General Ability	विषय कोड ----- S. Code	<input type="text" value="9"/> <input type="text" value="9"/>	अनक्रमांक ----- Roll Number	<input type="text" value="0"/> <input type="text" value="8"/> <input type="text" value="1"/> <input type="text" value="2"/> <input type="text" value="7"/> <input type="text" value="6"/>
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You should write with black ball pen the name of the centre and subject in English or Hindi. The test Booklet Series is indicated by Alphabets A, B, C or D at the top right hand corner of the Booklet.

Write your Roll Numbers exactly as it is in your **e-Admit Card** in the boxes provided for this purpose. Do not omit black pen. The name of the Centre need not be encoded.

Writing and any zero(s) which may be there.

The next step is to find out the appropriate subject code from the Time Table. Now encode the Test Booklet Series, Subject Code and the Roll Number in the circles provided for this purpose. Do the encoding with encoding of Test Booklet Series is to be done after receiving the Test Booklet and confirming the Booklet Series from the same.

For General Ability subject paper of 'A' Test Booklet Series you have to encode the subject code, which is 99. Do it thus.

पुस्तिका क्रम Booklet Series (A)	विषय कोड Subject Code 9 9
<input checked="" type="radio"/>	<input type="radio"/> 0 <input type="radio"/> 0
<input type="radio"/> B	<input type="radio"/> 1 <input type="radio"/> 1
<input type="radio"/> C	<input type="radio"/> 2 <input type="radio"/> 2
<input type="radio"/> D	<input type="radio"/> 3 <input type="radio"/> 3
	<input type="radio"/> 4 <input type="radio"/> 4
	<input type="radio"/> 5 <input type="radio"/> 5
	<input type="radio"/> 6 <input type="radio"/> 6
	<input type="radio"/> 7 <input type="radio"/> 7
	<input type="radio"/> 8 <input type="radio"/> 8
	<input checked="" type="radio"/> <input checked="" type="radio"/>

All that is required is to blacken completely the circle marked 'A' below the Booklet Series and below the subject code blacken completely the Circles for '9' (in the first vertical

