University of Mumbai
Syllabus for PET- 2020 Examination

Section A: Research Methodology and General Awareness

Research Methodology

Foundations of Research: Meaning, Objectives, Motivation, Utility. Concept of theory, empiricism, deductive and inductive theory.Characteristics of scientific methods, understanding the language of research, Concept, Construct, definition, Variable. Research Process

Problem Identification & Formulation: Research Question–Investigation Question Measurement Issues. Hypothesis–Qualities of a good Hypothesis-Null hypothesis & Alternative Hypothesis. Hypothesis Testing–Logic & Importance–Logic & Importance ***Research Design***: Concept and Importance in Research, Features of a good research Design: ExploratoryResearchDesign,concept,typesanduses,DescriptiveResearchDesigns:concept, types and uses. Experimental Design: Concept of Independent & Dependentvariables.

Qualitative and Quantitative Research: Qualitative research, Quantitative research, concept of measurement, causality, generalization, replication. Merging the two approaches. Types of data and data collection techniques

Measurement: Concept of measurement -what is measured? Problems in measurement in research – Validity and Reliability.Levels of measurement –Nominal, Ordinal, Interval,Ratio.***Sampling:*** Concepts of Statistical Population, Sample, Sampling Frame, Sampling Error, Sample Size, Non Response. Characteristics of a good sample. Probability Sample – Simple Random Sample, Systematic Sample, Stratified Random Sample & Multi-stage sampling. Determining size of the sample –Practical considerations in sampling and samplesize.

DataAnalysis:DataPreparation–Univariateanalysis(frequencytables,barcharts,piecharts, percentages), Bivariate analysis –Cross tabulations and Chi square test including testing hypothesis of association, Analysis of Variance(ANOVA)

Interpretation of Data and Report writing: Types of publication, Paper Writing, Layout of a Research Paper, Journals in Science, Impact factor of Journals, When and where to publish ? Ethical issues related to publishing, Plagiarism and Self Plagiarism.

Section B: Computer Applications

Mathematical Foundations **Linear Algebra:** Matrix Algebra, Systems of linear equations, Eigenvalues, Eigenvectors. **Set Theory & Algebra:** Sets; Relations; Functions; Groups; Partial Orders; Lattice; Boolean Algebra. **Combinatorics:** Permutations; Combinations; Counting; Summation; generating functions recurrence relations; asymptotics. **Graph Theory:** Connectivity; spanning trees; Cut vertices & edges; covering; matching; independent sets; Colouring; Planarity; Isomorphism. **Calculus:** Mean value theorems, Theorems of integral calculus, Evaluation of definite and improperintegrals,PartialDerivatives,Maximaandminima,Multipleintegrals,Fourierseries, Vector identities, Directional derivatives, Line integral, Surface integral, Volume integral, Stokes's theorem, Gauss's theorem, Green'stheorem. **Differential equations:** First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, **Probability and Statistics:** Sampling theorems, Conditional probability, Mean, Median, Mode, Standard Deviation, Random variables, Discrete and Continuous distributions, Poisson distribution, Normal distribution, Binomial distribution, Correlation analysis, Regression analysis. **Numerical Methods:** Solutions of nonlinear algebraic equations, Single and Multi-step methods for differential equations.	10%
Digital Logic: Logic functions, Minimization, Design and synthesis of combinational and sequential circuits; Number representation and computer arithmetic (fixed and floating point). **Computer Organization and Architecture:** Machine instructions and addressing modes, ALU and data-path, CPU control design, Memory interface, I/O interface (Interrupt and DMA mode), Instruction pipelining, Cache and main memory, Secondary storage	5%
Programming and Data Structures: Programming in C; Functions, Recursion, Parameter passing, Scope, Binding; Abstract data types, Arrays, Stacks, Queues, Linked Lists, Trees, Binary search trees, Binary heaps, File structures (sequential files, indexing, B and B+ trees), **Algorithms:** Analysis, Asymptotic notation, Notions of space and time complexity, Worst and average case analysis; Tree and graph traversals, Spanning trees, Shortest paths; Hashing, Sorting, Searching. Asymptotic analysis (best, worst, average cases) of time and space, upper and lower bounds, Basic concepts of complexity classes .	10%
Operating System: Processes, Threads, Inter-process communication, Concurrency, Synchronization, Deadlock, CPU scheduling, Memory management and virtual memory, File systems, I/O systems, Protection and security. Distributed Systems: Distributed System Structures, Distributed File Systems, Distributed Coordination, Special-Purpose Systems: Real-Time Systems, Multimedia Systems, General Overview Of The System, Introduction To The Kernel, The Buffer Cache, Internal Representation Of Files, System Calls For The File System, The Structure Of Processes, Process Control, Process Scheduling And Time, Memory Management Policies, The I/O Subsystem, Interprocess Communication, Multiprocessor Systems, Distributed Unix Systems.	15%
Networking: Concept of layering. LAN technologies (Ethernet). Flow and error control techniques,switching. IPv4/IPv6, routers and routing algorithms (distance vector, link state), subnetting . TCP/UDP and sockets, congestion control. Application layer protocols	5%

(DNS, SMTP, POP, FTP, HTTP). Basics of Wi-Fi. Network security: authentication, basics of public key and private key cryptography, digital signatures and certificates, firewalls.	
Databases : Operational data, Purpose of database system, Views of data, Data models: Relational, Network, Hierarchical, Instances & Schemes, Data Dictionary, Types of Database languages : DDL, DML, Structures of a DBMS, Advantages & Disadvantages of a DBMS,3-level Architecture Proposal : External, Conceptual & Internal Levels, ER-model, Relational model (relational algebra, tuple calculus), Database design (integrity constraints, normal forms), Object Oriented Model, Concurrency Control, Database Security. File Organization. Data warehousing Data Warehousing Components – Multi Dimensional Data Model – Data Warehouse Architecture – Data Warehouse Implementation – Mapping the Data Warehouse to Multiprocessor Architecture – OLAP – Need – Categorization of OLAP Tool	15%
Data Mining : Data Preprocessing And Association Rules : Data Preprocessing – Data Cleaning , Integration , Transformation ,Reduction ,Discretization Concept Hierarchies , Concept Description Data Generalization and Summarization Based Characterization, Mining Association Rules in Large Databases. Predictive Modeling: Classification and Prediction Issues Regarding Classification and Prediction, Classification by Decision Tree Induction, Bayesian Classification, Other Classification Method, Prediction ,Clusters Analysis, Types of Data in Cluster Analysis ,Categorization of Major Clustering Methods , Partitioning Methods, Hierarchical Methods.	15%
Artificial Intelligence Perspective: Problem spaces and search, Knowledge and rationality, Heuristic search strategies, Search and optimization (gradient descent). Soft Computing:NN- Types of Learning (Supervised, Unsupervised, Reinforcement), Activation Functions, Basic Models of Artificial Neural Network, Linear Separability, Back-Propagation Network, Feed forward NN, Error detection NN. FL-Fuzzy Relations, Fuzzification, De-fuzzification, Fuzzy Inference Systems (FIS)- Construction and Working Principle of FIS, Methods of FIS. GA- genetic algorithm and operations, Encoding methods, Fitness function, Working principle	15%
Machine Learning: Dimensionality reduction: Feature extraction - Principal component analysis, Singular value decomposition. Feature selection – feature ranking and subset selection, filter, wrapper and embedded methods. Hypothesis space, Forecasting and Learning Theory, Ensemble Methods , Reinforcement Learning	10%

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