Course Structure for S.Y.B.SC. (Computer science) (2024 Pattern)

Sem	Course Type	Course Code	Course Name	Theory / Practical	Credits
IV	Minor(Theory)	COS-256-MN(A)	Continuous Probability Distributions and Testing of Hypothesis	Theory	02
	Minor(practical)	COS-257-MN(A)	Minor Statistics Practical (CS) -II	Practical	02

CBCS Syllabus as per NEP 2.0 for T.Y.B.Sc. Computer Science (2023 Pattern)

Name of the Programme	**:** B.Sc.(Computer Science)
Programme Code	**:** USCOS
Class	**:** S.Y.B.Sc. (Computer Science)
Semester	**:** IV
Course Type	**:** Minor (Theory)
Course Code	**:** COS-256-MN(A)
Course Title	**:** Continuous Probability Distributions and Testing of Hypothesis
No. of Credits	**:** 02
No. of Teaching Hours	**:** 30

Course Objectives:

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

1. Understand the theoretical concepts of standard continuous probability distributions and their applications in real life.
2. Learn the properties of Uniform, Exponential, and Normal distributions and apply them to solve problems.
3. Acquire knowledge of the fundamental concepts of statistical hypothesis testing.
4. Develop the ability to formulate null and alternative hypotheses and understand p-values and confidence intervals.
5. Apply large sample tests (Z-tests) for population means and proportions with real-life data.
6. Gain proficiency in small sample tests (Chi-square, t-tests, and F-tests) and their applications.
7. Develop problem-solving and analytical skills for interpreting data using statistical inference techniques.

Course Outcomes:

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

CO1 Explain and derive the properties (mean, variance, shape) of Uniform, Exponential, and Normal distributions

CO2 Use Normal distribution and central limit theorem for approximating binomial and Poisson probabilities**.**

CO3 Apply the concept of hypothesis testing for real-world problems by defining null and alternative hypothesis.

CO4 Perform Z-tests for population means and proportions and construct confidence intervals for large samples

CO5 Apply Chi-square tests for independence, goodness of fit, and

variance tests.

CO6 Conduct t-tests (one sample, two sample, and paired) and compute confidence intervals for small samples.

CO7 Apply F-tests for comparing population variances and interpret statistical results in the context of practical applications

. Topics and Learning Points

UNIT 1: Standard Continuous Probability Distributions (10L)

1.1 Uniform Distribution: statement of p.d.f., mean, variance, nature of probability curve. Theorem (without proof): The distribution function of any continuous r.v. if it is Invertible follows U (0, 1) distribution

1.2 Exponential Distribution: statement of p.d.f. of the form f(x) = $\frac{1}{\theta}e^{-x/\theta}$, mean, Variance, nature of probability curve, lack of memory property. (Without proof)

1.3 Normal Distribution: statement of p.d.f., identification of parameters, nature of Probability density curve, standard normal distribution, symmetry, distribution of aX+b, aX+bY+c where X and Y are independent normal variables, computations of Probabilities using normal probability table, normal approximation to binomial and Poisson distribution, central limit theorem (statement only)

1.4 Numerical problems related to real life applications.

Unit 2: Introduction to Testing of Hypothesis (4L)

Parameter, random sample from a distribution as i.i.d. r.v.s. X_1, X_2… X_n, statistic, estimator, estimate, critical region. Statistical hypothesis, null and alternative hypothesis, one sided and two sided alternative hypothesis, p-value, Confidence interval, Procedure of testing of hypothesis.

Unit 3: Large Sample Tests (Tests based on Normal distribution) (7L)

3.1 Z-tests for population means:

3.1.1 One sample and two sample tests for one-sided and two-sided alternatives

3.1.2 Confidence Interval for Population Mean: 100(1- α) % two sided confidence interval for single population mean (μ) and difference of population means of two independent normal populations.

3.2 Z-tests for population proportions:

3.2.1 One sample and two sample tests for one-sided and two-sided alternatives

3.2.2 Confidence Interval for Population Proportion: 100(1-α) % two sided confidence interval for single population proportion (P) and difference of population proportions of two independent normal populations.

Unit 4: Small Sample Tests (Tests based on Normal distribution): (9L)

4.1 Tests based on Chi-square distribution:

4.1.1 Test for independence of two attributes

4.1.2 Test for Goodness of Fit (Without rounding off the expected frequencies) (Problems are not expected)

4.1.3 Test for $H_{0:}\ \sigma^2 = \sigma_0^2$ against one-sided and two-sided alternatives when mean is known, mean is unknown.

4.2 Tests based on t-distribution:

4.2.1 t-tests for population means: One sample and two sample tests for one-sided and two-sided alternatives.

4.2.2 Confidence Interval for Population Mean: 100(1- α) % two sided confidence interval for single population mean (μ) and difference of population means of two independent normal populations.

4.3 Paired t-test for one-sided and two-sided alternatives(.

4.4 Test based on F-distribution:

4.4.1 Test for $H_0: \sigma_1^2 = \sigma_2^2$ against one-sided and two-sided alternatives when means are known and means are unknown.

References:

1. A First course in Probability, Sheldon Ross. Pearson Education Inc.

2. Statistical Methods (An Introductory Text), Medhi J. 1992, New Age International.

3. Modern Elementary Statistics, Freund J.E. 2005, Pearson Publication.

4. Probability, Statistics, Design of Experiments and Queuing Theory with Applications of Computer Science, Trivedi K.S. 2001, Prentice Hall of India, New Delhi.

5. Gupta S. C. and Kapoor V. K.1987 Fundamentals of Mathematical Statistics (3rd Edition) S.Chand and Sons, New Delhi

6. Common Statistical Tests Kulkarni M.B., Ghatpande, S.B.,Gore S.D.1999 Satyajeet Prakashan,

7. Sinha S. K.: Reliability and Life Testing, Second Edition, Wiley Eastern Publishers, New Delhi.

8. Hogg R. V. and Craig R. G.: Introduction to Mathematical Statistics Ed.4.

9. Gupta and Kapoor: Fundamentals of Mathematical Statistics, Sultan Chand and Sons, New Delhi.

10. Meyer P.L. (1970): Introductory Probability and Statistical Applications, Edition Wesley.

11. Freedman D., PisaniR., Purves R. (2007), Statistics, Fourth Edition, W. W. Nortan and Company, New York

Programme Outcomes and Course Outcomes Mapping:

CO-PO Mapping Table:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1	3	2	1	2	2	1	1	2	1	1	1	2	1
CO2	3	2	1	2	3	1	2	2	2	1	1	2	1
CO3	2	3	1	2	3	2	2	2	2	1	1	2	1
CO4	2	3	1	3	3	2	2	2	2	1	1	2	1
CO5	2	3	1	3	3	2	2	2	2	1	1	2	1
CO6	2	3	1	3	3	2	2	2	2	1	1	2	1
CO7	2	3	1	3	3	2	2	2	2	1	1	2	1

This mapping table and the justifications show how each Course Outcome (CO) aligns with the Program Outcomes (POs) and the extent of their relationship.

Justification for Mapping PO and CO:

PO1: Comprehensive Knowledge and Understanding

- **CO1:**(2) The ability to define and calculate p.d.f., mean, and variance requires a solid understanding of foundational statistical concepts.
- **CO2:** (2) Applying the Exponential and Uniform distributions builds on a foundational understanding of probability theory and distribution properties.
- **CO3:** (2). Understanding the normal distribution and its applications is a core component of statistical theory
- **CO4:** (2) Using Chi-square, t, and F-distributions requires comprehensive knowledge of statistical methods.
- **CO5:** (2) Hypothesis testing is rooted in deep theoretical knowledge of statistics.
- **CO6:** (2) Analyzing data using parametric and non-parametric methods involves a strong grasp of statistical principles.
- **CO7:** (2) Applying large sample tests and F-tests also requires a solid understanding of underlying statistical theories.

PO2: Practical, Professional, and Procedural Knowledge

- **CO1:** (1) Defining and calculating p.d.f., mean, and variance are fundamental skills that have practical applications in various fields.

- **CO2:** (3) Applying distributions like Exponential and Uniform in real-life scenarios demonstrates practical professional knowledge.
- **CO3:** (3). The normal distribution is widely used in professional statistical analysis, making this CO strongly related to practical knowledge
- **CO4:** (3) The application of Chi-square, t, and F-distributions is a key practical skill in statistical testing.
- **CO5:** (3) Performing hypothesis tests is a critical professional procedure in data analysis and research
- **CO6:** (3). The use of testing methods is essential for practical data analysis in many industries
- **CO7:** (3) Applying large sample tests and F-tests has direct professional and procedural applications in statistical analysis.

PO3: Entrepreneurial Mindset and Knowledge

- **CO1:** (1) Understanding basic statistical measures can support data-driven decision-making in entrepreneurial contexts.
- **CO2:** (2). Solving real-life problems using distributions can aid in risk assessment and market analysis
- **CO3: (1)** Knowledge of the normal distribution can support quality control and operational decisions
- **CO4:** (1) Using statistical distributions in decision-making processes can enhance an entrepreneurial approach.
- **CO5:** (1) Hypothesis testing can support innovation by validating business strategies and processes
- **CO6:** (2). Analyzing data effectively is crucial for identifying market trends and opportunities
- **CO7:** (2) Applying large sample tests can assist in making informed business decisions and understanding market dynamics

PO4: Specialized Skills and Competencies

- **CO1:** (1) Calculating statistical measures develops technical and analytical skills.
- **CO2:** (2). Applying distributions to solve problems enhances problem-solving and analytical competencies.
- **CO3: (1)** Mastery of the normal distribution demonstrates specialized statistical skills
- **CO4:** (1) Proficiency in using Chi-square, t, and F-distributions is essential for specialized statistical analysis.
- **CO5:** (1) Hypothesis testing requires a high level of analytical reasoning and specialized skills.

- **CO6:** (2). The ability to analyze data using various methods is a key technical competency.

- **CO7:** (2) Conducting large sample tests and F-tests reflects advanced problem-solving skills.

PO5: Capacity for Application, Problem-Solving, and Analytical Reasoning

- **CO1:** (2) Calculating p.d.f., mean, and variance involves applying mathematical concepts to solve problems.
- **CO2:** (3). Applying distributions directly correlates with solving real-world problems
- **CO3: (3)** The normal distribution is fundamental to many analytical processes
- **CO4:** (3) Interpreting statistical distributions requires strong analytical reasoning.

- **CO5:** (3) Hypothesis testing is central to solving data-related problems
- **CO6:** (3). Analyzing data using statistical methods exemplifies the application of analytical reasoning.
- **CO7:** (3) Applying large sample tests and F-tests involves problem-solving at an advanced level

PO6: Communication Skills and Collaboration

- **CO1:** (1) Explaining statistical concepts and results improves communication skills.
- **CO2:** (1). Solving real-life problems can require collaboration with others to interpret results.
- **CO3: (1)** Knowledge of the normal distribution helps in communicating statistical findings.

- **CO4:** (1) Effective interpretation of statistical tests requires clear communication.
- **CO5:** (1) Hypothesis testing often involves collaboration in research or business environments.
- **CO6:** (1). Analysing data and reporting findings requires strong communication skills
- **CO7:** (1) Large sample tests and F-tests may require collaboration to interpret and report results

PO7: Research-related Skills

- **CO1:** (2) Calculating p.d.f., mean, and variance is foundational for statistical research.
- **CO2:** (2). Applying distributions in research settings demonstrates the ability to conduct data-driven inquiries.
- **CO3: (2)** Understanding the normal distribution is crucial for many research methodologies

- **CO4:** (2) Interpreting statistical distributions is a key research skill
- **CO5:** (2) Hypothesis testing is fundamental to research design and analysis.
- **CO6:** (2). Analyzing data using statistical methods is central to conducting research
- **CO7:** (2) Applying large sample tests and F-tests supports research-related data analysis.

PO8: Learning How to Learn Skills

- **CO1:** (1) Learning to calculate statistical measures fosters self-directed learning.
- **CO2:** (1) Applying distributions in new contexts encourages continuous learning.
- **CO3: (1)** Mastering the normal distribution involves learning new statistical techniques.
- **CO4:** (1) Interpreting and using statistical tests requires ongoing learning
- **CO5:** (1) Hypothesis testing involves adapting to new information and techniques.
- **CO6:** (1). Analyzing data using various methods supports the development of self-learning skills
- **CO7:** (1) Applying large sample tests and F-tests requires continuous adaptation and learning.

PO9: Digital and Technological Skills

- **CO1:** (1) Calculating statistical measures can involve the use of software tools
- **CO2:** (2). Applying distributions often requires technological tools for data analysis
- **CO3: (2)** The normal distribution is frequently analyzed using digital tools.
- **CO4:** (2) Statistical tests are commonly conducted using software.
- **CO5:** (2) Hypothesis testing is often performed with the help of technological tools.
- **CO6:** (2). Analyzing data using parametric and non-parametric methods requires digital proficiency.
- **CO7:** (2) Conducting large sample tests and F-tests involves using statistical software.

PO10: Multicultural Competence, Inclusive Spirit, and Empathy

- **CO1:** (1) Understanding statistical concepts can enhance communication across diverse settings.
- **CO2:** (1). Applying statistical methods can aid in addressing issues in multicultural contexts.

- **CO3: (1)** Knowledge of statistics can support decision-making in diverse environments.
- **CO4:** (1) Interpreting statistical results can foster understanding in multicultural settings.
- **CO5:** (1) Hypothesis testing can be applied to studies involving diverse populations.
- **CO6:** (1). Analyzing data can help address issues related to inclusivity and diversity.
- **CO7:** (1) Large sample tests and F-tests can be used to study diverse populations and

PO11: Value Inculcation and Environmental Awareness

- **CO1:** (1) Statistical knowledge can be applied to study environmental data..
- **CO2:** (1). Applying distributions can support sustainability studies.
- **CO3: (1)** Understanding the normal distribution can aid in environmental data analysis
- **CO4:** (1) Using statistical tests can help in environmental research..
- **CO5:** (1) Hypothesis testing can be applied to environmental studies..
- **CO6:** (1). Analyzing data can support environmental conservation efforts.
- **CO7:** (1) Large sample tests and F-tests can be used in environmental research.

PO12: Autonomy, Responsibility, and Accountability

- **CO1:** (1) Calculating statistical measures fosters independent problem-solving.
- **CO2:** (2). Applying distributions to solve problems requires accountability and responsibility in data analysis
- **CO3: (2)** Understanding and applying the normal distribution requires independent analysis.
- **CO4:** (2) Using statistical tests involves responsibility in interpreting results.
- **CO5:** (2) Hypothesis testing requires careful and accountable analysis.
- **CO6:** (2). Analyzing data using statistical methods demonstrates autonomy in research.
- **CO7:** (2) Applying large sample tests and F-tests requires responsibility and accountability in data interpretation.

PO13: Community Engagement and Service

- **CO1:** (1) Understanding statistics can support community-based research and services
- **CO2:** (1). Applying statistical methods can address community issues.
- **CO3: (1)** Interpreting data can inform community decisions and services.

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- **CO4:** (1) Statistical knowledge can be used to benefit community projects.
- **CO5:** (1) Hypothesis testing can support community research initiatives.
- **CO6:** (1). Analyzing data can help address issues related to inclusivity and diversity.
- **CO7:** (1) Large sample tests and F-tests can used for comparison in two localities

CBCS Syllabus as per NEP 2020 for S.Y.B.Sc. (Computer Science)
(2024 Pattern)

Name of the Programme	**:** B.Sc. Computer Science.
Programme Code	**:** USCOS
Class	**:** S.Y.B.Sc. (Computer Science)
Semester	**:** IV
Course Type	**:** Minor (Practical)
Course Code	**:** COS-257-MN(A)
Course Title	**:** Minor Statistics Practical (CS) -II
No. of Credits	**:** 02
No. of Teaching Hours	**:** 60

Course Objectives:

The main objectives of this practical course are:

1. To develop understanding of continuous probability distributions and their applications.
2. To provide hands-on practice in fitting statistical distributions to real and simulated data.
3. To enable students to perform statistical inference using large and small sample tests.
4. To familiarize students with model sampling methods from different probability distributions.
5. To train students in the use of modern statistical software (R) for analysis.
6. To encourage interpretation of results for solving real-life case studies.
7. To inculcate analytical thinking and problem-solving skills in the context of statistics.

Course Outcomes:

After completing the practical course, students will be able to:

CO1 Fit uniform and normal distributions and compute expected frequencies.

CO2 Apply normal and exponential distributions in solving applied problems.

CO3 Perform model sampling from uniform and normal distributions.

CO4 Demonstrate understanding of the nature and properties of continuous distributions.

CO5 Compute probabilities using continuous probability distributions.

CO6 Conduct large and small sample hypothesis tests, including Chi-square based tests.

CO7 Apply statistical methods and software tools to analyze real-life case studies.

Topics and Learning Points:

Sr. No.	Title of the Experiments
1	Fitting of Exponential distribution.
2	Fitting of normal distribution and computation of expected frequencies.
3	Applications of uniform, exponential and normal distributions.
4	Computations of probabilities of continuous probability distributions.
5	Model sampling from normal distribution.
6	Nature of probability distribution. (Continuous distributions).
7	Test for means based on normal distribution.
8	Test for proportions based on normal distribution.
9	Test based on t distributions and F distribution.
10	Test based on chi-square distribution (Independence of Attribute and Goodness of fit test) (Also using R Software)
11	Case study(Equivalent to 4 practicals)

Note:

1. Every practical is equivalent to four hours per batch per week
2. Practical batch should be of 12 students
3. Students must complete all the practical to the satisfaction of the teacher concerned.
4. Students must produce at the time of practical examination, the laboratory journal along with the completion certificate signed by the Head of the Department.

Reference:

1. Fundamentals of Mathematical Statistics S.C. Gupta and V.K. Kapoor
2. Probability and Statistics with R Maria Dolores Ugarte, Ana F. Militino, Alan T. Arnholt
3. Introduction to the Practice of Statistics David S. Moore, George P. McCabe, Bruce A. Craig
4. Statistical Methods S.P. Gupta
5. Applied Statistics and Probability for Engineers Douglas C. Montgomery and George C. Runger
6. Introduction to Probability and Statistics William Mendenhall, Robert J. Beaver, Barbara M. Beaver

Justification for CO-PO Mapping

PO1 Comprehensive Knowledge and Understanding

- **CO1 to CO7** Involve strong application and understanding of statistical theory, including distributions, hypothesis testing, and probability. Statistical concepts are foundational to the discipline.

PO2 Practical, Professional, and Procedural Knowledge

- **CO1 to CO7** Involves hands-on statistical analysis, sampling, hypothesis testing, and software use (e.g., R).Students apply theoretical concepts in practical lab settings.

PO3 Entrepreneurial Mindset and Knowledge

- **CO1 to CO7** Indirectly related through case studies and real-life application where decision-making is required. Encourages data-driven thinking, though not a central focus

PO4 Specialized Skills and Competencies

- **CO1 to CO7** Focus on analytical reasoning, problem-solving, and interpreting data. Required in all COs, especially CO3, CO5, CO6.

PO5 Application, Problem-Solving, and Analytical Reasoning

- **CO1 to CO7** Statistical methods are inherently problem-solving tools. Core to experiments like hypothesis testing and probability applications.

PO6 Communication Skills and Collaboration

- **CO1 to CO7** While communication is not the core, students do interpret results and present findings. Presenting case studies and test results requires basic reporting..

PO7 Research-related Skills

- CO6 and CO7 Directly align with statistical testing, data collection, and analysis. Lays the foundation for quantitative research methods.

PO8 Learning How to Learn

- **CO1 to CO7** Encourages independent problem-solving, especially through software and case studies. Self-learning required to work with tools and interpret results.

PO9 Digital and Technological Skills

- **CO1 to CO7** Use of R software and other tools for statistical analysis is core to this practical. Students gain hands-on experience with data analysis software

PO10 Multicultural Competence and Empathy

- **CO1 to CO7** Indirectly touched upon through team-based labs or diverse data sets. Not central, but has some relevance in collaborative settings

PO11 Value Inculcation and Environmental Awareness

- **CO1 to CO7** Only indirectly addressed through ethical data analysis and responsible reporting. Minimal relevance, but students learn to handle data ethically

PO12 Autonomy, Responsibility, and Accountability

- **CO1 to CO7** Practical tasks require independent execution, analysis, and submission. Students must carry out analysis and document results responsibly

- CO7 (Case study) May involve community-related data analysis. Real-world application of statistics to societal issues.