CUET Mathematics Test - Set 27

Unit IV: Probability Distributions (Intermediate to Advanced)

SOLUTIONS

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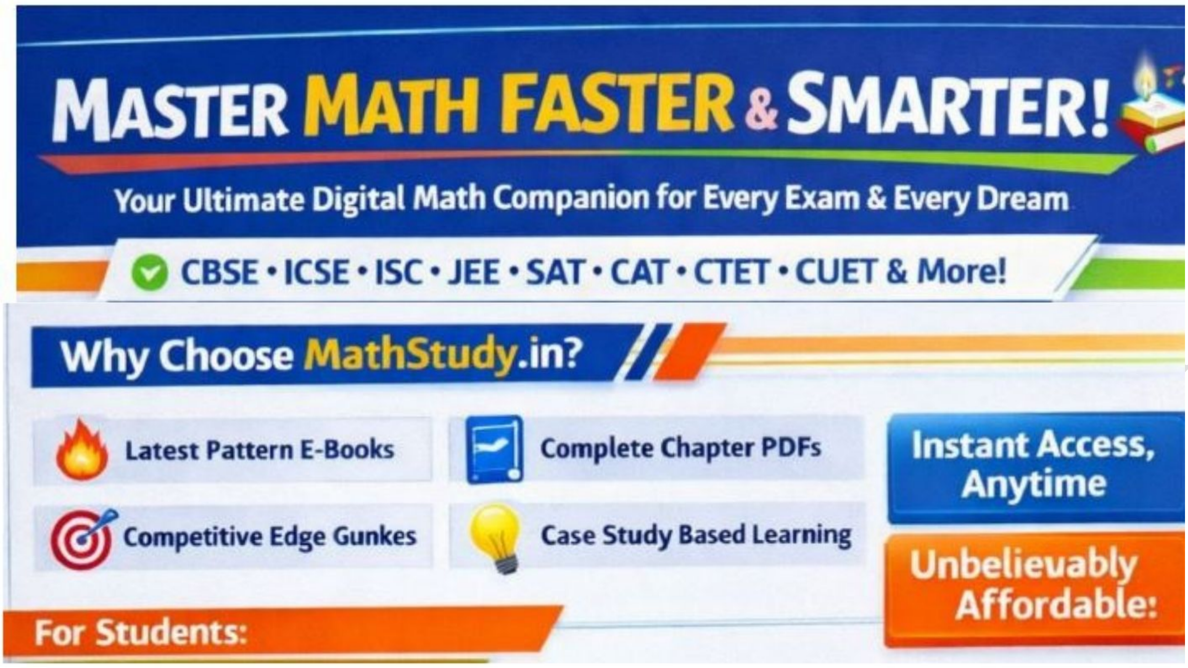

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Solutions

1. **Solution:** The expression $E[(X-a)^2]$ is minimized when $a = E(X)$. Given $E(X) = 10$, $a = 10$. **Correct Option: (C)**

2. **Solution:** $np = 20$ and $npq = 16$. $q = 16/20 = 0.8$. Thus $p = 1 - 0.8 = 0.2$. **Correct Option: (A)**

3. **Solution:** In a Poisson distribution, if the mode occurs at two points $k-1$ and k, then the mean $\lambda = k$. Here $k = 4$, so $\lambda = 4$. **Correct Option: (C)**

4. **Solution:** $P(X \geq 1) = 1 - P(X = 0) = 1 - e^{-\lambda}$. Given $1 - e^{-\lambda} = 1 - e^{-3} \implies \lambda = 3$. In Poisson, $Var(X) = \lambda = 3$. **Correct Option: (A)**

5. **Solution:** By the Empirical Rule for Normal Distribution, approx 95.4% of data falls within $\pm 2\sigma$. **Correct Option: (B)**

6. **Solution:** Total probability $\int_0^3 kx^2 dx = 1 \implies [k\frac{x^3}{3}]_0^3 = 1 \implies 9k = 1 \implies k = 1/9$. **Correct Option: (B)**

7. **Solution:** $n = 400, p = 0.1$. Mean $np = 40$. $Var = npq = 400(0.1)(0.9) = 36$. $SD = \sqrt{36} = 6$. **Correct Option: (A)**

8. **Solution:** $E[(2+X)^2] = E[4 + 4X + X^2] = 4 + 4E(X) + E(X^2)$. Since $Var(X) = E(X^2) - [E(X)]^2$, $5 = E(X^2) - 1^2 \implies E(X^2) = 6$. Total $= 4 + 4(1) + 6 = 14$. **Correct Option: (B)**

9. **Solution:** $np = 6, npq = 2 \implies q = 1/3, p = 2/3$. Since $p > 0.5$, the distribution is negatively skewed. **Correct Option: (C)**

10. **Solution:** This is a Binomial distribution problem with $n = 180$ and $p = 1/6$. $E(X) = np = 180 \times (1/6) = 30$. **Correct Option: (B)**

11. **Solution:** Substitute $P(X = x) = \frac{e^{-\lambda}\lambda^x}{x!}$. $\frac{\lambda^2}{2} = 9\frac{\lambda^4}{24} + 90\frac{\lambda^6}{720}$. Simplifying: $\frac{\lambda^2}{2} = \frac{3\lambda^4}{8} + \frac{\lambda^6}{8}$. Let $\lambda^2 = y$. Solve $y^2 + 3y - 4 = 0 \implies (y+4)(y-1) = 0 \implies y = 1 \implies \lambda = 1$. **Correct Option: (A)**

12. **Solution:** In a Normal curve $f(x) = \frac{1}{\sigma\sqrt{2\pi}}e^{-\frac{1}{2}(\frac{x-\mu}{\sigma})^2}$, the second derivative $f''(x) = 0$ at $x = \mu \pm \sigma$. **Correct Option: (A)**

13. **Solution:** $E[(X-2)^2] = E[X^2 - 4X + 4] = E(X^2) - 4E(X) + 4 = 8 - 4(2) + 4 = 4$. **Correct Option: (A)**

14. **Solution:** $p = 0.1, q = 0.9, n = 5$. $P(X \leq 1) = \binom{5}{0}(0.9)^5 + \binom{5}{1}(0.1)(0.9)^4 = (0.9)^5 + 5(0.1)(0.9)^4 = (0.9)^5 + 0.5(0.9)^4$. **Correct Option: (A)**

15. **Solution:** $E(X) = 2^1 = 2$. $E(X^2) = 2^2 = 4$. $Var(X) = E(X^2) - [E(X)]^2 = 4 - (2)^2 = 0$. **Correct Option: (A)**