

# Assignment2

CS20Btech11035 -NYALAPOGULA MANASWINI

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## GATE EC QUESTION 63

Suppose X is a real-valued random variable. Which of the following values CANNOT be attained by  $E[X]$  and  $E[X^2]$  respectively?

- (A) 0 and 1
- (B)  $\frac{1}{2}$  and  $\frac{1}{3}$
- (C) 2 and 3
- (D) 2 and 5

## SOLUTION

We know that

$$\text{var}(X) = E[(X - E[X])^2] \quad (0.0.1)$$

$$\text{var}(X) = E[X^2] - (E[X])^2 \quad (0.0.2)$$

For uniform distribution in the interval  $[a, b]$

$$\text{var}(X) = \frac{(b - a)^2}{12} \quad (0.0.3)$$

From (0.0.1), (0.0.3) (for uniform distribution), we can conclude that

$$\text{var}(X) \geq 0 \quad (0.0.4)$$

$$\therefore E[X^2] - (E[X])^2 \geq 0 \quad (0.0.5)$$

(A)  $E[X] = 0$  and  $E[X^2] = 1$

$$E[X^2] - (E[X])^2 = 1 - 0 \quad (0.0.6)$$

$$= 1 \quad (0.0.7)$$

$$\therefore E[X^2] - (E[X])^2 \geq 0 \quad (0.0.8)$$

$\therefore E[X] = 0$  and  $E[X^2] = 1$  can be attained

(B)  $E[X] = \frac{1}{2}$  and  $E[X^2] = \frac{1}{3}$

$$E[X^2] - (E[X])^2 = \frac{1}{3} - \frac{1}{4} \quad (0.0.9)$$

$$= \frac{1}{12} \quad (0.0.10)$$

$$\therefore E[X^2] - (E[X])^2 \geq 0 \quad (0.0.11)$$

$\therefore E[X] = \frac{1}{2}$  and  $E[X^2] = \frac{1}{3}$  can be attained

(C)  $E[X] = 2$  and  $E[X^2] = 3$

$$E[X^2] - (E[X])^2 = 3 - 4 \quad (0.0.12)$$

$$= -1 \quad (0.0.13)$$

$$\therefore E[X^2] - (E[X])^2 \leq 0 \quad (0.0.14)$$

$\therefore E[X] = 2$  and  $E[X^2] = 3$  cannot be attained

(D)  $E[X] = 2$  and  $E[X^2] = 5$

$$E[X^2] - (E[X])^2 = 5 - 4 \quad (0.0.15)$$

$$= 1 \quad (0.0.16)$$

$$\therefore E[X^2] - (E[X])^2 \geq 0 \quad (0.0.17)$$

$\therefore E[X] = 2$  and  $E[X^2] = 5$  can be attained

$\therefore E[X] = 2$  and  $E[X^2] = 3$  cannot be attained