

# Assignment 5

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Download all python codes from

[https://github.com/PRABHATH-cs20-11038/AI1103/tree/main/Assignment\\_5/Codes](https://github.com/PRABHATH-cs20-11038/AI1103/tree/main/Assignment_5/Codes)

and latex-tikz codes from

[https://github.com/PRABHATH-cs20-11038/AI1103/tree/main/Assignment\\_5](https://github.com/PRABHATH-cs20-11038/AI1103/tree/main/Assignment_5)

## 1 PROBLEM

(GATE(EC)2013 – 26Q) Let  $U$  and  $V$  be two independent zero mean Gaussian random variables of variances  $\frac{1}{4}$  and  $\frac{1}{9}$  respectively. The probability  $\Pr(3V \geq 2U)$  is

- (A)  $4/9$
- (B)  $1/2$
- (C)  $2/3$
- (D)  $5/9$

## 2 SOLUTION

$U$  and  $V$  are independent random variables,

$$V \sim N\left(0, \frac{1}{9}\right) \quad (2.0.1)$$

$$U \sim N\left(0, \frac{1}{4}\right) \quad (2.0.2)$$

Let,

$$Z = 3V - 2U \quad (2.0.3)$$

$$Z \sim N\left(0, 9 \times \frac{1}{9} + 4 \times \frac{1}{4}\right) \quad (2.0.4)$$

$$Z \sim N(0, 2) \quad (2.0.5)$$

For  $Z$ ,  $\mu = 0$ , and  $\sigma^2 = 2$ .

By Gaussian Distribution,  
PDF of  $Z$ ,

$$f_Z(z) = \frac{1}{\sqrt{2\pi\sigma}} e^{-\frac{(z-\mu)^2}{2\sigma^2}} \quad (2.0.6)$$

$$f_Z(z) = \frac{1}{2\sqrt{\pi}} e^{-\frac{z^2}{4}} \quad (2.0.7)$$

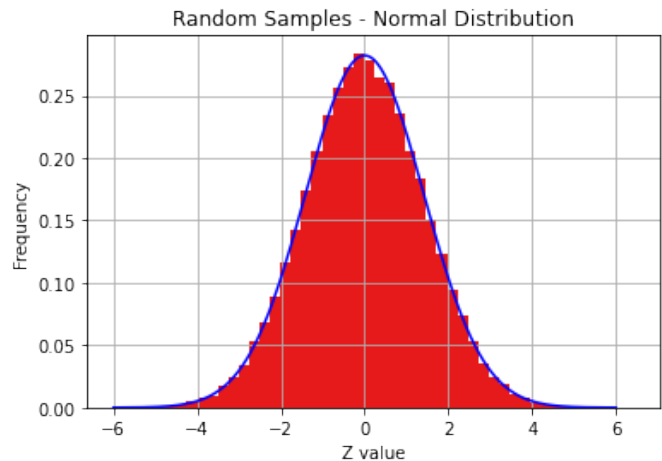


Fig. 4. Plot of of distribution function

Let  $F_Z(z)$  be CDF of  $Z$ ,

$$f_Z(z) = F'_Z(z) \quad (2.0.8)$$

$$\Pr(Z \geq 0) = F_Z(0) \quad (2.0.9)$$

From the result,

$$F_Z(\mu) = \frac{1}{2} \quad (2.0.10)$$

Here for  $Z$ ,  $\mu = 0$ ,

$$\Pr(Z \geq 0) = \frac{1}{2} \quad (2.0.11)$$

$$\Pr(3V - 2U \geq 0) = \frac{1}{2} \quad (2.0.12)$$

$$\Pr(3V \geq 2U) = \frac{1}{2} \quad (2.0.13)$$

Option (B) is correct.

Probability–  
simulated: 0.49873  
actual: 0.5