

**M.Sc. Economics**  
**Indian Institute of Technology Delhi**  
**Entrance Examination 2025**  
**SET A**



## Instructions: Read carefully

1. Write the appropriate question paper set, A or B, in the OMR sheet and darken the appropriate letter.
2. Please write your application number in the OMR sheet as follows. Write the last 5 digits (or, 4 digits as applicable) of your application number in the box and darken the correct number in the OMR sheet. For example, if your application number is PG-252601-0015, then write 0015 in the box starting from the first box and leave the last box blank. Also darken the appropriate digits below the boxes. If your application number is PG-252601-00150, then write 00150 in the boxes starting from the first box and darken the digits below the boxes.
3. Exam duration is 3 hours. You are not allowed to leave the exam hall before the end of the exam.
4. There are two sections. Section I has 20 one-mark questions. For each question in Section I, a correct answer fetches one mark, an incorrect answer penalizes negative  $\frac{1}{3}$ , and no answer gives no marks. Section II has 40 questions, with a correct answer getting two marks, an incorrect answer getting negative  $\frac{2}{3}$ , and no answer to a question getting zero.
5. Maximum possible marks is 100.
6. In Section II, a question may have more than one correct answer. In such a case, select all the correct answers. In Section I, only one option is correct.
7. You should use a black/blue ballpoint pen to darken the correct responses on the OMR sheet. See the OMR sheet for instructions on how to fill a bubble correctly.
8. A separate booklet with ruled pages is provided for rough work.
9. You will need to submit the entire question paper along with the OMR sheet. But take the rough work booklet with you when you leave the hall.
10. There should be 32 pages in the exam booklet. Check your copy and request a new booklet if you do not have 32 pages.
11. If any candidate is caught using unfair means during the exam, he/she will be immediately disqualified and will be asked to leave the exam hall.
12. Mobile phones, smart phones, smart watches, calculators, or any other electronic gadgets are NOT allowed inside the exam hall.

# I Multiple Choice Questions (One mark each)

1. Match the following economists with their famous contributions:

I. Robert Lucas	1. Foundations of Modern Welfare Economics
II. John Maynard Keynes	2. Quantity Theory of Money
III. Milton Friedman	3. Rational Expectations Hypothesis
IV. Paul Samuelson	4. General Theory of Employment, Interest, and Money

**A. I-3, II-4, III-2, IV-1**

B. I-3, II-4, III-1, IV-2

C. I-2, II-1, III-4, IV-3

D. I-4, II-3, III-2, IV-1

2. Consider the utility function  $u(x, y) = \sqrt{xy}$ , where  $x$  and  $y$  are quantities of good 1 and good 2 respectively. Then the two goods are:

A. Net and gross substitutes.

B. Net substitutes and gross complements.

**C. Net substitutes and neither gross substitutes nor complements.**

D. Net and gross complements.

3. A casino offers a gamble in which a fair coin is flipped repeatedly until it lands on heads. The payout for the gambler is  $2^n$  rupees, where  $n$  is the number of flips until the first head appears. What is the expected value of this gamble?

A.  $\infty$

B.  $2^n$

C.  $n$

D. 0

4. If  $f : R \rightarrow R$  is a differentiable function and  $f(2) = 6$ , then  $\lim_{x \rightarrow 2} \int_6^{f(x)} \frac{2tdt}{(x-2)}$  is

**A.  $12f'(2)$**

B. 0

C.  $24f'(2)$

D.  $2f'(2)$

5. What is the primary effect of an expansionary fiscal policy in a small open economy with a floating exchange rate and perfect capital mobility?

A. It raises income and depreciates the exchange rate.

**B. It has no effect on income but leads to exchange rate appreciation.**

C. It lowers income and depreciates the exchange rate.  
D. It raises income without affecting the exchange rate.

6. Is the following statement TRUE or FALSE?

STATEMENT: The weight attached to food (within the basket of goods and services) is greater in WPI than in CPI.

A. The statement is true.  
**B. The statement is false.**  
C. The statement refers to fuel, not food.  
D. The weights are equal in both indices.

7. All figures are in a common unit. Private consumption = 600, Investment = 120, Government expenditure = 70, Net Factor Payment from Abroad = 32, GDP = 922, Taxes = 65 and Disposable income = 1140. Then the National Saving is

A. 822  
B. 954  
C. 164  
**D. 284**

8. Which statement best describes a parameter?

A. A parameter is a level of confidence associated with an interval about a sample mean or proportion.  
**B. A parameter is a numerical measure of a population that is almost always unknown and must be estimated.**  
C. A parameter is a sample size that guarantees the error in estimation is within acceptable limits.  
D. A parameter is an unbiased estimate of a statistic found by experimentation or polling.

9. In a closed economy with a Keynesian consumption function and completely interest-inelastic investment, what will be the slope of the Aggregate Demand (AD) curve?

**A. Perfectly vertical.**  
B. Perfectly horizontal.  
C. Downward sloping.  
D. Upward sloping.

10. Quasi-concavity of utility functions with  $n$  goods ensures that these goods must be:

A. Gross complements.

- B. Net substitutes.
- C. Net complements.

**D. Not possible say without having more information.**

11. Amy likes chocolate and spinach. Given any two bundles  $x, y$  of these two goods, she strictly prefers  $x$  as long as it contains more chocolate than  $y$ . If  $x, y$  have the same amount of chocolate, she strictly prefers the bundle that has more spinach.

- A. Her preferences satisfy all four axioms of consumer choice (completeness, transitivity, continuity, and strict monotonicity).
- B. There are two distinct consumption bundles  $x, y$  such that Amy is indifferent between  $x$  and  $y$ .
- C. Her preferences satisfy all axioms except for continuity.**
- D. Her preferences can be represented by a utility function.

12. Emile has constant absolute risk aversion and initial wealth  $w$  and prefers not to take between a gamble where with probability 0.5 she would win  $x$  and with probability 0.5 she would lose  $y$ . Is it possible that if Emile's wealth were much greater, she would want to accept the gamble?

- A. There is not enough information to answer.
- B. Yes, for some parameter values.
- C. It depends on the functional form of the utility function.

**D. No.**

13. A sample of 26 IIT Delhi students' heights has a mean of 165 cm, a median of 160 cm, and a mode of 155 cm. Which of the following statements is most likely true about the shape of the distribution of these heights?

- A. The distribution is platykurtic.
- B. The distribution is negatively skewed.
- C. The distribution is positively skewed.**
- D. The distribution is leptokurtic.

14. What is the confidence level of the confidence interval  $\bar{x} \pm 2.33 \left( \frac{\sigma}{\sqrt{n}} \right)$  for the population mean  $\mu$ ? [A standard normal table is provided at the end of the question paper for your reference.]

- A. 233%
- B. 90%
- C. 99%**
- D. 78%

15. Let  $X$  and  $Y$  be two events such that  $\Pr(X) = \frac{1}{3}$ ,  $\Pr(X \mid Y) = \frac{1}{2}$  and  $\Pr(Y \mid X) = \frac{2}{5}$ . Then

- A.  $\Pr(X \cap Y^c) = \frac{1}{2}$ .
- B.  $\Pr(X \cap Y) = \frac{1}{5}$ .
- C.  $\Pr(X \cup Y) = \frac{7}{15}$ .
- D.  $\Pr(Y) = \frac{8}{15}$ .

16. Consider the system of equations  $ax + by = 1$ ;  $cx + dy = 2$ , where  $a, b, c, d \in \{0, 1\}$ . The probability that the system of equations has a unique solution is

- A.  $\frac{3}{8}$
- B.  $\frac{1}{2}$
- C.  $\frac{5}{8}$
- D.  $\frac{1}{4}$

17. If  $E$  and  $F$  are events with  $\Pr(E) \leq \Pr(F)$  and  $\Pr(E \cap F) > 0$ , then

- A. Occurrence of  $E \Rightarrow$  occurrence of  $F$ .
- B. Occurrence of  $F \Rightarrow$  occurrence of  $E$ .
- C. Non-occurrence of  $E \Rightarrow$  non-occurrence of  $F$ .
- D. None of the above holds.**

18. Three of six vertices of a regular hexagon are chosen at random. The probability that the triangle with three vertices is equilateral, equals

- A.  $\frac{1}{2}$
- B.  $\frac{1}{5}$
- C.  $\frac{1}{10}$
- D.  $\frac{1}{20}$

19. Words of length 10 are formed using the letters  $A, B, C, D, E, F, G, H, I, J$ . Let  $x$  be the number of such words where no letter is repeated; and let  $y$  be the number of such words where exactly one letter is repeated twice and no other letter is repeated. Then,  $\frac{y}{9x} =$

- A. 5**
- B. 8
- C. 4
- D. 9

20. Which of the following is more likely to occur when the Central Bank finances the fiscal deficit?

- A. Rise in inflation.**
- B. Rise in interest rates.
- C. Both rise in inflation and rise in interest rates.
- D. Neither rise in inflation and rise in interest rates.

## II Multiple Select Questions (Two marks each)

21. The random variables  $X$  and  $Y$  are distributed independently. Consider the following two statements.

**Statement I:**  $Var(Y|X) = Var(Y)$

**Statement II:** The random variables  $X^2$  and  $Y^2$  are also independently distributed

- A. Statement I is TRUE but Statement II is FALSE.
- B. Statement I is FALSE but Statement II is TRUE.
- C. **Statement I and II both are TRUE.**
- D. Statement I and II both are FALSE.

22. The price elasticity of a demand function  $D = D(P)$  is defined as follows:

$$\epsilon_D = \left| \frac{\frac{dD}{dP}}{\frac{D}{P}} \right|$$

where  $D$  is the quantity demanded and  $P$  is the price. Indicate the correct statement(s):

- A.  $\epsilon_D$  is a unit-free concept.
- B. Suppose that the plot of  $\ln D$  against  $\ln P$  is a downward sloping straight line.  $\epsilon_D$  in this case changes negatively with  $P$ .
- C. You have data on the slope of the demand function at a *given* price and quantity level.  $\epsilon_D$  can be calculated at that point on the demand function.
- D. Inverse aggregate demand function in a perfectly competitive market is perfectly inelastic.

23. Assume that labour is the only input, and the firms charge a fixed margin over the cost. If money wages increase by 10%, labour productivity increases by 5%, and the margin remains constant, what is the approximate percentage change in the price level?

- A. 5% increase.
- B. 15% increase.
- C. 5% decrease.
- D. No change.

24. Which of the following statements is (are) correct?

- A. Every strictly dominant strategy is also weakly dominant.

- B. In a  $2 \times 2$  game, if there are multiple Nash equilibria in pure strategies, then one equilibrium always Pareto dominates others.
- C. Every never-best response is also a strictly dominated strategy, in pure strategies.
- D. A unique strategy profile survives the process of iterated elimination of strictly dominated strategies.

25. Suppose a consumer lives for two periods and has quadratic utility:

$$u(c) = -\frac{1}{2}(c - \bar{c})^2$$

where  $c$  is the level of consumption and  $\bar{c}$  is a big constant ( $c < \bar{c}$ ). Let the time preference rate  $\delta$ , and the interest rate  $r$  be equal and both positive. Assume there are no taxes, no bequests and the consumer can borrow and lend freely at rate  $r$ . The consumer earns  $y_1$  in period 1 with certainty, but income in period 2 is uncertain. Let  $c_1$  and  $c_2$  be the optimal levels of consumption in period 1 and 2, respectively. Which one of the following statements is correct?

- A.  $E(c_2) = c_1 + r$
- B.  $E(c_2) = \delta c_1$
- C.  $E(c_2) = c_1$
- D.  $c_2 = c_1$  always.

26. A monopolist who operates on two separate markets and has the same constant marginal cost in both markets charges

- A. A higher price in the market with a more elastic demand curve.
- B. **A higher price in the market with a less elastic demand curve.**
- C. The same price in both markets since his marginal cost is the same.
- D. Not enough information.

27. Suppose  $X$  is a normally distributed random variable with mean 0 and variance 1. In addition,  $g$  is a differentiable function with finite  $\mathbb{E}(Xg(X))$ , and  $\mathbb{E}(g'(X))$ . Consider the following statements.

1.  $\mathbb{E}(Xg(X)) = \mathbb{E}(g'(X))$ .
2.  $\mathbb{E}(\exp(tX)) = \exp\left(\frac{t^2}{2}\right)$ .

The following holds

- A. **Statement (1) and (2) are correct.**
- B. Statement (1) is correct and (2) is not correct.
- C. Statement (1) is not correct and (2) is correct.
- D. Statement (1) and (2) are not correct.

28. A monopolist faces a market demand curve given by  $P = 10,010 - 50Q$ . The monopolist's marginal revenue curve is given by  $MR = 10,010 - 100Q$ . The monopolist produces at a constant marginal cost of  $MC = \$10$ . The difference in total welfare between this situation and perfect competition is:

- A. \$5,000
- B. \$5010
- C. \$500,000
- D. None of the above.**

29. Given the production function  $Y = AK^{0.4}L^{0.6}$ , if output  $Y$ , capital  $K$ , and labour  $L$  are growing at rates of 4%, 5%, and 8% respectively, what is the Total Factor Productivity (TFP) growth rate?

- A. -2.8%**
- B. 0.8%
- C. -1.0%
- D. 1.2%

30. Consider the following strategic form game in Figure 1. Find all the Nash Equilibria (NE) in pure strategies.

		Player 2		
		Rock	Paper	Scissor
Player 1	Rock	0, 0	-1, 1	1, -1
	Paper	1, -1	0, 0	-1, 1
	Scissor	-1, 1	1, -1	0, 0

Figure 1: A strategic form game

- A. NE are (Paper, Rock), (Scissor, Paper) and (Rock, Scissor).
- B. NE are (Scissor, Rock), (Rock, Paper) and (Paper, Scissor).
- C. NE are all action-profiles mentioned in A and B.
- D. No NE in pure strategies.**

31. Suppose weak preference  $\succeq$  is complete and transitive. Then, which of the following is (are) incorrect?

- A.  $x \succ y$  if and only if it is not the case that  $y \succeq x$ .
- B. If  $x \succ y$ , then for any third element  $z$ , either  $z \succ y$  or  $x \succ z$ .
- C. If  $x \succ y$  and  $y \succeq z$ , then  $x \succ z$  and if  $x \succeq y$  and  $y \succ z$ , then  $x \succ z$ .

D. Can't say that  $x \sim x$ , for all  $x$ .

32. Which of the following options (is) are correct?

- Any preference relation can be represented by a continuous utility function.
- Indifference curves can never intersect each other.**
- Utility function is quasi-concave if and only if the lower contour set is convex.
- Indifference curves are linear for perfect complements.

33. A and B can consume cheese and beer. Each of them have Leontief preferences i.e. each of them has a level of utility equal to the minimum of  $x, y$  where  $x$  = beer consumption and  $y$  = cheese consumption. A has an endowment of 10 units of cheese, and B an endowment of 10 units of beer. Which of the following is/are correct?

- Any Pareto-efficient allocation gives both A and B equal amounts of cheese.
- Any Pareto-efficient allocation gives A equal amounts of cheese and beer.**
- The unique competitive equilibrium is where the relative price of cheese and beer is 1, and each of A and B consume 5 units of cheese and 5 units of beer.
- The unique competitive equilibrium is where the relative price of cheese and beer is 1, and each of A and B consume 5 units of cheese and 4 units of beer.

34. Suppose the total public debt-to-GDP ratio is 60%, and the primary deficit-to-GDP ratio is 1% in period  $t - 1$ . If the real interest rate is 4%, the real GDP growth rate is 2%, then the change in the debt-to-GDP ratio between  $t - 1$  and  $t$  is

- 1.15%
- 2.18%**
- 2.65%
- 3.35%

35. If the supply curve shifts back while the demand function is held the same, the price rises and the quantity at equilibrium shrinks. Indicate the correct statement(s) for this case where  $\epsilon_D$  denotes the absolute elasticity of demand.

- If the total expenditure rises as the supply curve shifts back,  $\epsilon_D$  must be less than 1.**
- If the total expenditure rises as the supply curve shifts back,  $\epsilon_D$  must be greater than 1.
- If  $\epsilon_D = 1$ , the total expenditure remains the constant as price rises and quantity falls along the demand function.**

D. It is not possible to infer on total expenditure without information on the elasticity of supply along with demand.

**Answer the next three questions using the following information.**

Consider a closed economy IS-LM model with the following specifications.

$C = 10 + 0.8(Y - T)$	Consumption
$T = 10 + 0.1Y$	Tax
$I = 120.6 - 16.8r$	Investment
$G = 79$	Government spending
$\frac{M}{P} = 70$	Real money supply
$L(Y, r) = \begin{cases} -1125 - 10r + Y & \text{if } Y > 1200 \\ 75 - 10r & \text{if } Y \leq 1200 \end{cases}$	Real money demand

36. At the equilibrium,

- The government runs a balanced budget.**
- The government incurs a budget deficit.
- The government has a budget surplus.
- The government saving is equal to the private saving.

37. Suppose the government undertakes an expansionary fiscal policy by increasing  $G$  by 100 units. The effects on equilibrium output and interest rates are

- $Y$  increases by less than 100 units and  $r$  increases by one unit.
- $Y$  increases by more than 100 units and  $r$  remains unchanged.**
- $Y$  increases by more than 100 units and  $r$  decreases by one unit.
- $Y$  remains unchanged and  $r$  increases by one unit.

38. If the central bank increases the real money supply by 30 units, then

- $Y$  increases and  $r$  decreases.
- $Y$  increases and  $r$  remains unchanged.
- $Y$  remains unchanged and  $r$  decreases.
- Both  $Y$  and  $r$  remain unchanged.**

39. Suppose you are trying to connect with a student from your college who lives within 5 km of your residence. You know that 60% of the 2,500 students at your college live within this distance. If you start contacting students from the college at random, what is the probability that the first 3 people you contact do not live within 5 km?

- 0.1296

**B. 0.064**

C. 0.216

D. 0.144

40. Suppose the expectations-augmented Phillips Curve is given by:

$$\pi_t = \pi_t^e - (u_t - 5\%),$$

where  $\pi_t$  is the inflation rate,  $\pi_t^e$  is the expected inflation rate, and  $u_t$  is the unemployment rate at  $t$ . Expected inflation is formed adaptively as the average of the central bank's inflation target (2%) and the actual inflation rate in the previous period:

$$\pi_t^e = \frac{1}{2} (2\% + \pi_{t-1}).$$

Suppose the inflation rate in period  $t - 1$  is 12%, and the central bank maintains the unemployment rate at one percentage point above the natural rate starting from period  $t$  and continuing in all subsequent periods. What will be the inflation rate in period  $t + 1$ ?

A. 4.0%

B. 5.5%

**C. 3.0%**

D. 6.5%

41. The Westernlands produces two goods: milk and butter. Quantities are measured in gallons and prices in silver stags per gallon.

Goods	2015		2016	
	Quantity	Price	Quantity	Price
Milk	500	2	900	3
Butter	2000	1	3000	2

Based on the above data, what is the percentage increase in the GDP deflator from 2015 to 2016 using 2015 as the base year?

A. 60.00%

**B. 81.25%**

C. 83.33%

D. 123.00%

42. Let  $X_i = u_i + \varepsilon_i$  for  $i = 1, \dots, n$ , where  $u_i$  is a fixed and  $\varepsilon_i$  is a random variable. Random variables  $\varepsilon_i$  for  $i = 1, \dots, n$  are i.i.d. with CDF

$$F(e) = \exp(-\exp(-e)),$$

and density

$$f(e) = \exp(-\exp(-e)) \exp(-e).$$

Then  $\Pr(X_i \geq X_j, \forall j \neq i)$  is

A.  $\frac{1}{1 + \sum_{j \neq i} \exp(u_j)}$

B.  $\frac{1}{1 + \sum_{j \neq i} \exp(u_j - u_i)}$

C.  $\frac{1}{1 + \sum_{j \neq i} \exp(u_i - u_j)}$

D.  $\frac{1}{\sum_{j=1}^n \exp(u_j)}$

43. Suppose that

- Box-I contains 8 red, 3 blue and 5 green balls,
- Box-II contains 24 red, 9 blue and 15 green balls,
- Box-III contains 1 blue, 12 green and 3 yellow balls,
- Box-IV contains 10 green, 16 orange and 6 white balls.

A ball is chosen randomly from Box-I ; call this ball  $b$ . If  $b$  is red then a ball is chosen randomly from Box-II, if  $b$  is blue then a ball is chosen randomly from Box-III, and if  $b$  is green then a ball is chosen randomly from Box-IV. The conditional probability of the event one of the chosen balls is white given that the event at least one of the chosen balls is green has happened, is equal to

A.  $\frac{15}{256}$

B.  $\frac{3}{16}$

C.  $\frac{5}{52}$

D.  $\frac{1}{8}$

44.  $X_i$ 's are independent and identically distributed random variables. Each  $X_i$  follows a standard normal distribution, where  $i \in \{1, 2, \dots, n\}$ . Find the mean of the random variable

$$Y = \sum_{i=1}^n X_i^2,$$

which follows a Chi-square distribution with  $n$  degrees of freedom.

A.  $n$

B.  $2n$

C.  $\sqrt{n}$

D.  $n^2$

45. Suppose the random variables  $(X, Y)$  are jointly distributed with probability density function

$$f(x, y) = \begin{cases} x + y & \text{if } 0 \leq x \leq 1 \text{ and } 0 \leq y \leq 1, \\ 0 & \text{otherwise.} \end{cases}$$

What is the  $Cov(X, Y)$ ?

- A.  $\frac{1}{144}$
- B.  $\frac{1}{12}$
- C.  $-\frac{1}{12}$
- D.  $-\frac{1}{144}$**

46. Suppose you roll two independent dice (with six sides) and  $M$  records the number of dots in the highest rolling dice. What is the expected value of  $M$  or  $\mathbb{E}(M)$ ?

- A. 3.5
- B. 1
- C. 4.47**
- D.  $\frac{91}{36}$

47.  $X$ ,  $Y$ , and  $Z$  are three continuous random variables modeling failure times of three power transistors with mean failure times of 500, 800, and 400 hours, respectively. These transistors fail independently of each other. Furthermore, they constitute a power system that fails if one of the three transistors fails. What is the expected time until the power system fails?

- A.  $\frac{1}{500} \times \frac{1}{800} \times \frac{1}{400}$
- B.  $\frac{1}{500} + \frac{1}{800} + \frac{1}{400}$
- C.  $\frac{1}{\frac{1}{500} + \frac{1}{800} + \frac{1}{400}}$
- D.  $\frac{1}{\frac{1}{500} \times \frac{1}{800} \times \frac{1}{400}}$**

48. Which of the following set is not a linear space?

- A. The set of solutions  $x$  of  $Ax = 0$ , where  $A$  is an  $m \times n$  matrix.
- B. The set of  $2 \times 2$  matrices  $A$  with  $\det(A) = 0$ .**
- C. The set of polynomials  $p(x)$  with  $\int_{-1}^1 p(x)dx = 0$ .

D. The set of solutions  $y = y(t)$  of  $y'' + 4y' + y = 0$ .

49. Let  $S = (0, 1) \cup (1, 2) \cup (3, 4)$  and  $T = \{0, 1, 2, 3\}$ . Then which of the following statements is true ?

A. Every continuous function from  $S$  to  $T$  is differentiable.  
 B. There are finitely many functions from  $S$  to  $T$ .  
 C. There are finitely many strictly increasing functions from  $S$  to  $T$ .  
 D. The number of continuous functions from  $S$  to  $T$  is at most 120.

50. Suppose  $A$  is a  $6 \times 6$  diagonalizable matrix with characteristic polynomial

$$C_A(x) = x^2(x - 3)^2(x - 4)(x - 5)$$

What is the rank of  $A$  ?

A. 2  
 B. 3  
**C. 4**  
 D. 5

51. Let  $A$  and  $B$  be the  $2 \times 2$  matrices

$$A = \begin{bmatrix} 3 & 1 \\ 0 & 4 \end{bmatrix} \quad B = \begin{bmatrix} 3 & 1 \\ 0 & 3 \end{bmatrix}$$

Which of the following statements is most accurate?

A. Neither  $A$  nor  $B$  is diagonalizable.  
 B. Both  $A$  and  $B$  are diagonalizable.  
**C.  $A$  is diagonalizable but  $B$  is not.**  
 D.  $B$  is diagonalizable but  $A$  is not.

52. Let  $f : \mathbb{R} \rightarrow \mathbb{R}$  be given by  $f(x) = (x-1)(x-2)(x-5)$ . Define  $F(x) = \int_0^x f(t)dt, x > 0$ . Then which of the following options is correct ?

A.  $F$  has a local maxima at  $x = 1$ .  
**B.  $F$  has a local maxima at  $x = 2$ .**  
 C.  $F$  has a local maxima at  $x = 5$ .  
 D.  $F$  has two local maxima and one local minimum in  $(0, \infty)$ .

53. For  $3 \times 3$  matrices  $M$  and  $N$ , which of the following statement(s) is correct?

A.  $N^T M N$  is symmetric.  
**B.  $MN - NM$  is skew symmetric for all symmetric  $M$  and  $N$ .**

C.  $MN$  is symmetric for all symmetric matrices  $M$  and  $N$ .

D.  $(\text{adj } M)(\text{adj } N) = \text{adj}(MN)$  for all invertible matrices  $M$  and  $N$ .

54. Let  $f(x)$  be a continuously differentiable function on the interval  $(0, \infty)$  such that  $f(1) = 2$  and

$$\lim_{t \rightarrow x} \frac{t^{10}f(x) - x^{10}f(t)}{t^9 - x^9} = 1$$

for each  $x > 0$ . Then, for all  $x > 0$ ,  $f(x)$  is equal to

A.  $\frac{31}{11x} - \frac{9}{11}x^{10}$   
B.  $\frac{9}{11x} + \frac{13}{11}x^{10}$   
C.  $\frac{-9}{11x} + \frac{31}{11}x^{10}$   
D.  $\frac{13}{11x} + \frac{9}{11}x^{10}$

55. Consider all rectangles lying in the region

$$\left\{ (x, y) \in \mathbb{R} \times \mathbb{R} : 0 \leq x \leq \frac{\pi}{2} \text{ and } 0 \leq y \leq 2 \sin(2x) \right\}$$

and having one side on the  $x$ -axis. The area of the rectangle which has the maximum perimeter among all such rectangles, is

A.  $\frac{3\pi}{2}$   
B.  $\pi$   
C.  $\frac{\pi}{2\sqrt{3}}$   
D.  $\frac{\pi\sqrt{3}}{2}$

56. Consider the following optimization problem

$$\theta^* = \arg \max_{\theta} (y - \theta)^2 + 2\lambda|\theta|.$$

The following holds for  $\theta^*$

A.  $\theta^*$  is continuous in  $y$ .  
B.  $\theta^*$  is continuous everywhere except  $y = \lambda$  and  $y = -\lambda$ .  
C.  $\theta^*$  is continuous everywhere except  $y = 0$ .  
D.  $\theta^*$  doesn't exist everywhere as objective function is not differentiable.

57. Let  $m$  be the minimum possible value of  $\log_3(3^{y_1} + 3^{y_2} + 3^{y_3})$ , where  $y_1, y_2, y_3$  are real numbers for which  $y_1 + y_2 + y_3 = 9$ . Let  $M$  be the maximum possible value of  $(\log_3 x_1 + \log_3 x_2 + \log_3 x_3)$ , where  $x_1, x_2, x_3$  are positive real numbers for which  $x_1 + x_2 + x_3 = 9$ . Then the value of  $mn$  is

**A. 12**

- B. 10
- C. 8
- D. 14

58. Let  $y(x)$  be a solution of the differential equation  $(1 + e^x) y' + ye^x = 1$ . If  $y(0) = 2$ , then which of the following statements is true ?

- A.  $y(x)$  has a critical point in the interval  $(0, 1)$ .
- B.  $y(x)$  has a critical point in the interval  $(-2, -1)$ .
- C.  $y(x)$  has a critical point in the interval  $(-1, 0)$ .**
- D.  $y(x)$  has critical point in the interval  $(1, 2)$ .

59. The least value of  $\alpha \in \mathbb{R}$  for which  $4\alpha x^2 + \frac{1}{x} \geq 1$ , for all  $x > 0$ , is

- A.  $\frac{1}{64}$
- B.  $\frac{1}{32}$
- C.  $\frac{1}{27}$**
- D.  $\frac{1}{25}$

60. Let  $X$  be a positive random variable with CDF  $F$ . The following is true

- A.  $\mathbb{E}(X) = \int_0^\infty (1 - F(t))dt$**
- B.  $\mathbb{E}(X) = \int_0^\infty F(t)dt$
- C.  $\mathbb{E}(X) = \int_0^\infty d(1 - F(t))$
- D.  $\mathbb{E}(X) = \int_0^\infty d(F(t))$

**STANDARD NORMAL DISTRIBUTION: Table Values Represent AREA to the LEFT of the Z score.**

Z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
<b>-3.9</b>	.00005	.00005	.00004	.00004	.00004	.00004	.00004	.00004	.00003	.00001
<b>-3.8</b>	.00007	.00007	.00007	.00006	.00006	.00006	.00006	.00005	.00005	.00001
<b>-3.7</b>	.00011	.00010	.00010	.00010	.00009	.00009	.00008	.00008	.00008	.00001
<b>-3.6</b>	.00016	.00015	.00015	.00014	.00014	.00013	.00013	.00012	.00012	.00001
<b>-3.5</b>	.00023	.00022	.00022	.00021	.00020	.00019	.00019	.00018	.00017	.00001
<b>-3.4</b>	.00034	.00032	.00031	.00030	.00029	.00028	.00027	.00026	.00025	.00002
<b>-3.3</b>	.00048	.00047	.00045	.00043	.00042	.00040	.00039	.00038	.00036	.00003
<b>-3.2</b>	.00069	.00066	.00064	.00062	.00060	.00058	.00056	.00054	.00052	.00005
<b>-3.1</b>	.00097	.00094	.00090	.00087	.00084	.00082	.00079	.00076	.00074	.00007
<b>-3.0</b>	.00135	.00131	.00126	.00122	.00118	.00114	.00111	.00107	.00104	.00101
<b>-2.9</b>	.00187	.00181	.00175	.00169	.00164	.00159	.00154	.00149	.00144	.00131
<b>-2.8</b>	.00256	.00248	.00240	.00233	.00226	.00219	.00212	.00205	.00199	.00191
<b>-2.7</b>	.00347	.00336	.00326	.00317	.00307	.00298	.00289	.00280	.00272	.00261
<b>-2.6</b>	.00466	.00453	.00440	.00427	.00415	.00402	.00391	.00379	.00368	.00351
<b>-2.5</b>	.00621	.00604	.00587	.00570	.00554	.00539	.00523	.00508	.00494	.00481
<b>-2.4</b>	.00820	.00798	.00776	.00755	.00734	.00714	.00695	.00676	.00657	.00631
<b>-2.3</b>	.01072	.01044	.01017	.00990	.00964	.00939	.00914	.00889	.00866	.00841
<b>-2.2</b>	.01390	.01355	.01321	.01287	.01255	.01222	.01191	.01160	.01130	.01100
<b>-2.1</b>	.01786	.01743	.01700	.01659	.01618	.01578	.01539	.01500	.01463	.01421
<b>-2.0</b>	.02275	.02222	.02169	.02118	.02068	.02018	.01970	.01923	.01876	.01831
<b>-1.9</b>	.02872	.02807	.02743	.02680	.02619	.02559	.02500	.02442	.02385	.02331
<b>-1.8</b>	.03593	.03515	.03438	.03362	.03288	.03216	.03144	.03074	.03005	.02931
<b>-1.7</b>	.04457	.04363	.04272	.04182	.04093	.04006	.03920	.03836	.03754	.03671
<b>-1.6</b>	.05480	.05370	.05262	.05155	.05050	.04947	.04846	.04746	.04648	.04551
<b>-1.5</b>	.06681	.06552	.06426	.06301	.06178	.06057	.05938	.05821	.05705	.05591
<b>-1.4</b>	.08076	.07927	.07780	.07636	.07493	.07353	.07215	.07078	.06944	.06811
<b>-1.3</b>	.09680	.09510	.09342	.09176	.09012	.08851	.08691	.08534	.08379	.08221
<b>-1.2</b>	.11507	.11314	.11123	.10935	.10749	.10565	.10383	.10204	.10027	.09851
<b>-1.1</b>	.13567	.13350	.13136	.12924	.12714	.12507	.12302	.12100	.11900	.11701
<b>-1.0</b>	.15866	.15625	.15386	.15151	.14917	.14686	.14457	.14231	.14007	.13781
<b>-0.9</b>	.18406	.18141	.17879	.17619	.17361	.17106	.16853	.16602	.16354	.16101
<b>-0.8</b>	.21186	.20897	.20611	.20327	.20045	.19766	.19489	.19215	.18943	.18671
<b>-0.7</b>	.24196	.23885	.23576	.23270	.22965	.22663	.22363	.22065	.21770	.21471
<b>-0.6</b>	.27425	.27093	.26763	.26435	.26109	.25785	.25463	.25143	.24825	.24511
<b>-0.5</b>	.30854	.30503	.30153	.29806	.29460	.29116	.28774	.28434	.28096	.27761
<b>-0.4</b>	.34458	.34090	.33724	.33360	.32997	.32636	.32276	.31918	.31561	.31201
<b>-0.3</b>	.38209	.37828	.37448	.37070	.36693	.36317	.35942	.35569	.35197	.34821
<b>-0.2</b>	.42074	.41683	.41294	.40905	.40517	.40129	.39743	.39358	.38974	.38591
<b>-0.1</b>	.46017	.45620	.45224	.44828	.44433	.44038	.43644	.43251	.42858	.42461
<b>-0.0</b>	.50000	.49601	.49202	.48803	.48405	.48006	.47608	.47210	.46812	.46411

## Rough work

## Solutions Set -

Q.No. 1 A  
Q.No. 2 C  
Q.No. 4 A  
Q.No. 5 B  
Q.No. 6 B  
Q.No. 7 D  
Q.No. 9 A  
Q.No. 10 D  
Q.No. 11 C  
Q.No. 12 D  
Q.No. 15 C  
Q.No. 16 A  
Q.No. 17 D  
Q.No. 18 C  
Q.No. 19 A  
Q.No. 20 A  
Q.No. 22 A  
Q.No. 22 C  
Q.No. 23 A  
Q.No. 24 A  
Q.No. 25 C  
Q.No. 26 B  
Q.No. 27 A  
Q.No. 28 D  
Q.No. 29 A  
Q.No. 30 D  
Q.No. 31 D  
Q.No. 32 B  
Q.No. 33 B  
Q.No. 34 B  
Q.No. 35 A  
Q.No. 35 C  
Q.No. 36 A  
Q.No. 37 B  
Q.No. 38 D  
Q.No. 40 C  
Q.No. 41 B  
Q.No. 42 B  
Q.No. 43 C  
Q.No. 48 B  
Q.No. 49 A  
Q.No. 50 C  
Q.No. 51 C  
Q.No. 52 B  
Q.No. 53 B  
Q.No. 54 B  
Q.No. 55 C  
Q.No. 56 A  
Q.No. 57 A  
Q.No. 58 C  
Q.No. 59 C  
Q.No. 60 A