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# UPSC NDA-II

**Previous Year Paper**  
**(Mathematics)**  
**03 Sept, 2023**

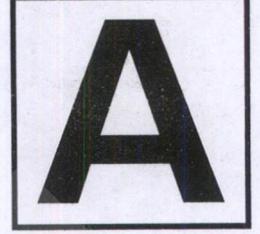


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**T.B.C. : DFTK-S-MTH**

**Test Booklet Series**

**TEST BOOKLET  
MATHEMATICS**



**Time Allowed : Two Hours and Thirty Minutes**

**Maximum Marks : 300**

**INSTRUCTIONS**

1. IMMEDIATELY AFTER THE COMMENCEMENT OF THE EXAMINATION, YOU SHOULD CHECK THAT THIS TEST BOOKLET DOES **NOT** HAVE ANY UNPRINTED OR TORN OR MISSING PAGES OR ITEMS, ETC. IF SO, GET IT REPLACED BY A COMPLETE TEST BOOKLET.
2. Please note that it is the candidate's responsibility to encode and fill in the Roll Number and Test Booklet Series Code A, B, C or D carefully and without any omission or discrepancy at the appropriate places in the OMR Answer Sheet. Any omission/discrepancy will render the Answer Sheet liable for rejection.
3. You have to enter your Roll Number on the Test Booklet in the Box provided alongside.  
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4. This Test Booklet contains **120** items (questions). Each item is printed both in **Hindi** and **English**. Each item comprises four responses (answers). You will select the response which you want to mark on the Answer Sheet. In case you feel that there is more than one correct response, mark the response which you consider the best. In any case, choose **ONLY ONE** response for each item.
5. You have to mark all your responses **ONLY** on the separate Answer Sheet provided. See directions in the Answer Sheet.
6. **All** items carry equal marks.
7. Before you proceed to mark in the Answer Sheet the response to various items in the Test Booklet, you have to fill in some particulars in the Answer Sheet as per instructions sent to you with your Admission Certificate.
8. After you have completed filling in all your responses on the Answer Sheet and the examination has concluded, you should hand over to the Invigilator **only the Answer Sheet**. You are permitted to take away with you the Test Booklet.
9. Sheets for rough work are appended in the Test Booklet at the end.
10. **Penalty for wrong answers :**  
**THERE WILL BE PENALTY FOR WRONG ANSWERS MARKED BY A CANDIDATE IN THE OBJECTIVE TYPE QUESTION PAPERS.**
  - (i) There are four alternatives for the answer to every question. For each question for which a wrong answer has been given by the candidate, **one-third** of the marks assigned to that question will be deducted as penalty.
  - (ii) If a candidate gives more than one answer, it will be treated as a **wrong answer** even if one of the given answers happens to be correct and there will be same penalty as above to that question.
  - (iii) If a question is left blank, i.e., no answer is given by the candidate, there will be **no penalty** for that question.

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ध्यान दें : अनुदेशों का हिन्दी रूपान्तर इस पुस्तिका के मुख पृष्ठ पर छपा है ।

1. If  $z\bar{z} = |z + \bar{z}|$ , where  $z = x + iy$ ,  $i = \sqrt{-1}$ , then the locus of  $z$  is a pair of :
- straight lines
  - rectangular hyperbolas
  - parabolas
  - circles
2. If  $1! + 3! + 5! + 7! + \dots + 199!$  is divided by 24, what is the remainder ?
- 3
  - 6
  - 7
  - 9
3. What is the value of  $\sqrt{12+5i} + \sqrt{12-5i}$ , where  $i = \sqrt{-1}$  ?
- 24
  - 25
  - $5\sqrt{2}$
  - $5(\sqrt{2} - 1)$
4. If  $A = \begin{bmatrix} 1 \\ 2 \\ 3 \end{bmatrix}$ , then what is the value of  $\det(I + AA')$ , where  $I$  is the  $3 \times 3$  identity matrix ?
- 15
  - 6
  - 0
  - 1
5. If  $A, B$  and  $C$  are square matrices of order 3 and  $\det(BC) = 2 \det(A)$ , then what is the value of  $\det(2A^{-1}BC)$  ?
- 16
  - 8
  - 4
  - 2
6. If the  $n^{\text{th}}$  term of a sequence is  $\frac{2n+5}{7}$ , then what is the sum of its first 140 terms ?
- 2840
  - 2780
  - 2920
  - 5700
7. Let  $A$  be a skew-symmetric matrix of order 3. What is the value of  $\det(4A^4) - \det(3A^3) + \det(2A^2) - \det(A) + \det(-I)$  where  $I$  is the identity matrix of order 3 ?
- 1
  - 0
  - 1
  - 2

8. If  $A = \begin{bmatrix} 0 & 3 & 4 \\ -3 & 0 & 5 \\ -4 & -5 & 0 \end{bmatrix}$ , then which one of the

following statements is correct ?

- (a)  $A^2$  is symmetric matrix with  $\det(A^2) = 0$ .
- (b)  $A^2$  is symmetric matrix with  $\det(A^2) \neq 0$ .
- (c)  $A^2$  is skew-symmetric matrix with  $\det(A^2) = 0$ .
- (d)  $A^2$  is skew-symmetric matrix with  $\det(A^2) \neq 0$ .

9. If  $A = \begin{bmatrix} 2 & 0 & 0 \\ 0 & 3 & 0 \\ 0 & 0 & 4 \end{bmatrix}$ , then which of the following

statements are correct ?

- 1.  $A^n$  will always be singular for any positive integer  $n$ .
- 2.  $A^n$  will always be a diagonal matrix for any positive integer  $n$ .
- 3.  $A^n$  will always be a symmetric matrix for any positive integer  $n$ .

Select the correct answer using the code given below :

- (a) 1 and 2 only
- (b) 2 and 3 only
- (c) 1 and 3 only
- (d) 1, 2 and 3

10. If  $(a + b)$ ,  $2b$ ,  $(b + c)$  are in HP, then which one of the following is correct ?

- (a)  $a$ ,  $b$  and  $c$  are in AP
- (b)  $a - b$ ,  $b - c$  and  $c - a$  are in AP
- (c)  $a$ ,  $b$  and  $c$  are in GP
- (d)  $a - b$ ,  $b - c$  and  $c - a$  are in GP

11. Let  $t_1, t_2, t_3 \dots$  be in GP. What is  $(t_1 t_3 \dots t_{21})^{\frac{1}{11}}$  equal to ?

- (a)  $t_{10}$
- (b)  $t_{10}^2$
- (c)  $t_{11}$
- (d)  $t_{11}^2$

12. Which one of the following is a square root of  $-\sqrt{-1}$  ?

- (a)  $1 + i$
- (b)  $\frac{1 - i}{\sqrt{2}}$
- (c)  $\frac{1 + i}{\sqrt{2}}$
- (d)  $\frac{1}{\sqrt{2}}i$

13. What is the maximum number of points of intersection of 10 circles ?

- (a) 45
- (b) 60
- (c) 90
- (d) 120

14. A set  $S$  contains  $(2n + 1)$  elements. There are 4096 subsets of  $S$  which contain at most  $n$  elements. What is  $n$  equal to ?

- (a) 5
- (b) 6
- (c) 7
- (d) 8

15. If 
$$\begin{vmatrix} x^2 + 3x & x - 1 & x + 3 \\ x + 1 & -2x & x - 4 \\ x - 3 & x + 4 & 3x \end{vmatrix} = ax^4 + bx^3 + cx^2 + dx + e,$$

then what is the value of  $e$ ?

- (a) -1
- (b) 0
- (c) 1
- (d) 2

16. If all elements of a third order determinant are equal to 1 or -1, then the value of the determinant is:

- (a) 0 only
- (b) an even number but not necessarily 0
- (c) an odd number
- (d) 0, 1 or -1

17. If  $A = \begin{bmatrix} 2 & -1 & 0 \\ -1 & 3 & 0 \\ 1 & 0 & 1 \end{bmatrix}$ , then what is the value of  $\det[\text{adj}(\text{adj}A)]$ ?

- (a) 5
- (b) 25
- (c) 125
- (d) 625

18. If  $A = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$ , then what is

$23A^3 - 19A^2 - 4A$  equal to?

- (a) Null matrix of order 3
- (b) Identity matrix of order 3

(c)  $\begin{bmatrix} 2 & 0 & 0 \\ 0 & 2 & 0 \\ 0 & 0 & 2 \end{bmatrix}$

(d)  $\begin{bmatrix} 7 & 0 & 0 \\ 0 & 7 & 0 \\ 0 & 0 & 7 \end{bmatrix}$

19. The value of the determinant of a matrix  $A$  of order 3 is 3. If  $C$  is the matrix of cofactors of the matrix  $A$ , then what is the value of determinant of  $C^2$ ?

- (a) 3
- (b) 9
- (c) 81
- (d) 729

20. If  $A_k = \begin{bmatrix} k-1 & k \\ k-2 & k+1 \end{bmatrix}$ , then what is

$\det(A_1) + \det(A_2) + \det(A_3) + \dots + \det(A_{100})$  equal to?

- (a) 100
- (b) 1000
- (c) 9900
- (d) 10000

21. The Cartesian product  $A \times A$  has 16 elements among which are  $(0, 2)$  and  $(1, 3)$ . Which of the following statements is/are correct?

1. It is possible to determine set  $A$ .
2.  $A \times A$  contains the element  $(3, 2)$ .

Select the correct answer using the code given below :

- (a) 1 only
- (b) 2 only
- (c) Both 1 and 2
- (d) Neither 1 nor 2

22. Let  $A = \{1, 2, 3, \dots, 20\}$ . Define a relation  $R$  from  $A$  to  $A$  by  $R = \{(x, y) : 4x - 3y = 1\}$ , where  $x, y \in A$ . Which of the following statements is/are correct?

1. The domain of  $R$  is  $\{1, 4, 7, 10, 13, 16\}$ .
2. The range of  $R$  is  $\{1, 5, 9, 13, 17\}$ .
3. The range of  $R$  is equal to codomain of  $R$ .

Select the correct answer using the code given below :

- (a) 1 only
- (b) 2 only
- (c) 1 and 2
- (d) 2 and 3

23. Consider the following statements :

1. The relation  $f$  defined by

$$f(x) = \begin{cases} x^3, & 0 \leq x \leq 2 \\ 4x, & 2 \leq x \leq 8 \end{cases} \text{ is a function.}$$

2. The relation  $g$  defined by

$$g(x) = \begin{cases} x^2, & 0 \leq x \leq 4 \\ 3x, & 4 \leq x \leq 8 \end{cases} \text{ is a function.}$$

Which of the statements given above is/are correct?

- (a) 1 only
- (b) 2 only
- (c) Both 1 and 2
- (d) Neither 1 nor 2

24. Consider the following statements :

1.  $A = (A \cup B) \cup (A - B)$

2.  $A \cup (B - A) = (A \cup B)$

3.  $B = (A \cup B) - (A - B)$

Which of the statements given above are correct?

- (a) 1 and 2 only
- (b) 2 and 3 only
- (c) 1 and 3 only
- (d) 1, 2 and 3

25. A function satisfies  $f(x - y) = \frac{f(x)}{f(y)}$ , where  $f(y) \neq 0$ . If  $f(1) = 0.5$ , then what is  $f(2) + f(3) + f(4) + f(5) + f(6)$  equal to ?
- (a)  $\frac{15}{32}$   
 (b)  $\frac{17}{32}$   
 (c)  $\frac{29}{64}$   
 (d)  $\frac{31}{64}$
26. What is  $2 \cot\left(\frac{1}{2} \cos^{-1} \frac{\sqrt{5}}{3}\right)$  equal to ?
- (a)  $-1$   
 (b)  $1$   
 (c)  $3 + \sqrt{5}$   
 (d)  $3 - \sqrt{5}$
27. If  $\sec^{-1} p - \operatorname{cosec}^{-1} q = 0$ , where  $p > 0, q > 0$ ; then what is the value of  $p^{-2} + q^{-2}$  ?
- (a)  $1$   
 (b)  $2$   
 (c)  $\frac{1}{2}$   
 (d)  $\frac{1}{2\sqrt{2}}$
28. What is  $1 + \sin^2\left(\cos^{-1}\left(\frac{3}{\sqrt{17}}\right)\right)$  equal to ?
- (a)  $\frac{25}{17}$   
 (b)  $\frac{8}{17}$   
 (c)  $\frac{9}{17}$   
 (d)  $\frac{47}{17}$
29. If  $\tan(\pi \cos \theta) = \cot(\pi \sin \theta)$ ,  $0 < \theta < \frac{\pi}{2}$ ; then what is the value of  $8 \sin^2\left(\theta + \frac{\pi}{4}\right)$  ?
- (a)  $16$   
 (b)  $2$   
 (c)  $1$   
 (d)  $\frac{1}{2}$
30. If  $\tan \alpha = \frac{1}{7}$ ,  $\sin \beta = \frac{1}{\sqrt{10}}$ ;  $0 < \alpha, \beta < \frac{\pi}{2}$ , then what is the value of  $\cos(\alpha + 2\beta)$  ?
- (a)  $-\frac{1}{2}$   
 (b)  $-\frac{1}{\sqrt{2}}$   
 (c)  $\frac{1}{\sqrt{2}}$   
 (d)  $\frac{1}{2}$

Consider the following for the next two (02) items that follow :

Consider the equation  $(1 - x)^4 + (5 - x)^4 = 82$ .

31. What is the number of real roots of the equation ?

- (a) 0
- (b) 2
- (c) 4
- (d) 8

32. What is the sum of all the roots of the equation ?

- (a) 24
- (b) 12
- (c) 10
- (d) 6

Consider the following for the next three (03) items that follow :

Consider equation-I :  $z^3 + 2z^2 + 2z + 1 = 0$  and equation-II :  $z^{1985} + z^{100} + 1 = 0$ .

33. What are the roots of equation-I ?

- (a)  $1, \omega, \omega^2$
- (b)  $-1, \omega, \omega^2$
- (c)  $1, -\omega, \omega^2$
- (d)  $-1, -\omega, -\omega^2$

34. Which one of the following is a root of equation-II ?

- (a)  $-1$
- (b)  $-\omega$
- (c)  $-\omega^2$
- (d)  $\omega$

35. What is the number of common roots of equation-I and equation-II ?

- (a) 0
- (b) 1
- (c) 2
- (d) 3

Consider the following for the next two (02) items that follow :

A quadratic equation is given by  $(a + b)x^2 - (a + b + c)x + k = 0$ , where  $a, b, c$  are real.

36. If  $k = \frac{c}{2}$ , ( $c \neq 0$ ), then the roots of the equation are :

- (a) Real and equal
- (b) Real and unequal
- (c) Real iff  $a > c$
- (d) Complex but not real

37. If  $k = c$ , then the roots of the equation are :

- (a)  $\frac{a+c}{a+b}$  and  $\frac{b}{a+b}$
- (b)  $\frac{a+c}{a+b}$  and  $-\frac{b}{a+b}$
- (c) 1 and  $\frac{c}{a+b}$
- (d)  $-1$  and  $-\frac{c}{a+b}$

Consider the following for the next three (03) items that follow :

Let  $(1+x)^n = 1 + T_1x + T_2x^2 + T_3x^3 + \dots + T_nx^n$ .

38. What is  $T_1 + 2T_2 + 3T_3 + \dots + nT_n$  equal to ?

- (a) 0
- (b) 1
- (c)  $2^n$
- (d)  $n2^{n-1}$

39. What is  $1 - T_1 + 2T_2 - 3T_3 + \dots + (-1)^n nT_n$  equal to ?

- (a) 0
- (b)  $-2^{n-1}$
- (c)  $n2^{n-1}$
- (d) 1

40. What is  $T_1 + T_2 + T_3 + \dots + T_n$  equal to ?

- (a)  $2^n$
- (b)  $2^n - 1$
- (c)  $2^{n-1}$
- (d)  $2^n + 1$

Consider the following for the next two (02) items that follow :

Let  $f(x) = x^2 - 1$  and  $\text{gof}(x) = x - \sqrt{x} + 1$ .

41. Which one of the following is a possible expression for  $g(x)$  ?

- (a)  $\sqrt{x+1} - \sqrt[4]{x+1}$
- (b)  $\sqrt{x+1} - \sqrt[4]{x+1} + 1$
- (c)  $\sqrt{x+1} + \sqrt[4]{x+1}$
- (d)  $x+1 - \sqrt{x+1} + 1$

42. What is  $g(15)$  equal to ?

- (a) 1
- (b) 2
- (c) 3
- (d) 4

Consider the following for the next two (02) items that follow :

Let a function  $f$  be defined on  $\mathbb{R} - \{0\}$  and  $2f(x) + f\left(\frac{1}{x}\right) = x + 3$ .

43. What is  $f(0.5)$  equal to ?

- (a)  $\frac{1}{2}$
- (b)  $\frac{2}{3}$
- (c) 1
- (d) 2

44. If  $f$  is differentiable, then what is  $f'(0.5)$  equal to ?

- (a)  $\frac{1}{4}$
- (b)  $\frac{2}{3}$
- (c) 2
- (d) 4

Consider the following for the next two (02) items that follow :

A function is defined by

$$f(x) = \begin{vmatrix} x+1 & 2 & 3 \\ 2 & x+4 & 6 \\ 3 & 6 & x+9 \end{vmatrix}$$

45. The function is decreasing on :

- (a)  $\left[-\frac{28}{3}, 0\right]$
- (b)  $\left[0, \frac{28}{3}\right]$
- (c)  $\left[0, \frac{50}{3}\right]$
- (d)  $\left[0, \frac{56}{3}\right]$

46. The function attains local minimum value at :

- (a)  $x = -\frac{28}{3}$
- (b)  $x = -1$
- (c)  $x = 0$
- (d)  $x = \frac{28}{3}$

Consider the following for the next two (02) items that follow :

Given that  $4x^2 + y^2 = 9$ .

47. What is the maximum value of  $y$  ?

- (a)  $\frac{3}{2}$
- (b) 3
- (c) 4
- (d) 6

48. What is the maximum value of  $xy$  ?

- (a)  $\frac{9}{4}$
- (b)  $\frac{3}{2}$
- (c)  $\frac{4}{9}$
- (d)  $\frac{2}{3}$

Consider the following for the next two (02) items that follow :

A function is defined by  $f(x) = \pi + \sin^2 x$ .

49. What is the range of the function ?

- (a)  $[0, 1]$
- (b)  $[\pi, \pi + 1]$
- (c)  $[\pi - 1, \pi + 1]$
- (d)  $[\pi - 1, \pi - 1]$

50. What is the period of the function ?

- (a)  $2\pi$
- (b)  $\pi$
- (c)  $\frac{\pi}{2}$
- (d) The function is non-periodic

Consider the following for the next two (02) items that follow :

A parabola passes through (1, 2) and satisfies the differential equation  $\frac{dy}{dx} = \frac{2y}{x}$ ,  $x > 0$ ,  $y > 0$ .

51. What is the directrix of the parabola ?

- (a)  $y = -\frac{1}{8}$
- (b)  $y = \frac{1}{8}$
- (c)  $x = -\frac{1}{8}$
- (d)  $x = \frac{1}{8}$

52. What is the length of latus rectum of the parabola ?

- (a) 1
- (b)  $\frac{1}{2}$
- (c)  $\frac{1}{4}$
- (d)  $\frac{1}{8}$

Consider the following for the next two (02) items that follow :

Let  $f(x) = \frac{a^{x-1} + b^{x-1}}{2}$  and  $g(x) = x - 1$ .

53. What is  $\lim_{x \rightarrow 1} \frac{f(x) - 1}{g(x)}$  equal to ?

- (a)  $\frac{\ln(ab)}{4}$
- (b)  $\frac{\ln(ab)}{2}$
- (c)  $\ln(ab)$
- (d)  $2 \ln(ab)$

54. What is  $\lim_{x \rightarrow 1} f(x)^{\frac{1}{g(x)}}$  equal to ?

- (a)  $\sqrt{ab}$
- (b)  $ab$
- (c)  $2ab$
- (d)  $\frac{\sqrt{ab}}{2}$

Consider the following for the next two (02) items that follow :

Let  $f(x) = \sqrt{2-x} + \sqrt{2+x}$ .

55. What is the domain of the function ?

- (a)  $(-2, 2)$
- (b)  $[-2, 2]$
- (c)  $\mathbb{R} - (-2, 2)$
- (d)  $\mathbb{R} - [-2, 2]$

56. What is the greatest value of the function ?

- (a)  $\sqrt{3}$
- (b)  $\sqrt{6}$
- (c)  $\sqrt{8}$
- (d) 4

Consider the following for the next two (02) items that follow :

Let  $f(x) = |x|$  and  $g(x) = [x] - 1$ , where  $[.]$  is the greatest integer function.

Let  $h(x) = \frac{f(g(x))}{g(f(x))}$ .

57. What is  $\lim_{x \rightarrow 0^+} h(x)$  equal to ?

- (a) -2
- (b) -1
- (c) 0
- (d) 1

58. What is  $\lim_{x \rightarrow 0^-} h(x)$  equal to?

- (a) -2
- (b) -1
- (c) 0
- (d) 2

Consider the following for the next two (02) items that follow :

$$\text{Let } f(x) = \begin{cases} \frac{x-3}{|x-3|} + a; & x < 3 \\ a - b; & x = 3 \text{ and} \\ \frac{x-3}{|x-3|} + b; & x > 3 \end{cases}$$

$f(x)$  be continuous at  $x = 3$ .

59. What is the value of  $a$ ?

- (a) -1
- (b) 1
- (c) 2
- (d) 3

60. What is the value of  $b$ ?

- (a) -1
- (b) 1
- (c) 2
- (d) 3

Consider the following for the next two (02) items that follow :

$$\text{Let } I = \int_{-2\pi}^{2\pi} \frac{\sin^4 x + \cos^4 x}{1 + 3^x} dx$$

61. What is  $\int_0^{\pi} (\sin^4 x + \cos^4 x) dx$  equal to?

- (a)  $\frac{3\pi}{8}$
- (b)  $\frac{3\pi}{4}$
- (c)  $\frac{3\pi}{2}$
- (d)  $3\pi$

62. What is  $I$  equal to?

- (a) 0
- (b)  $\frac{3\pi}{4}$
- (c)  $\frac{3\pi}{2}$
- (d)  $3\pi$

Consider the following for the next two (02) items that follow :

$$\text{Let } f(x) = \begin{cases} ax(x+1) + b, & x < 1 \\ x - 1, & 1 \leq x \leq 2 \end{cases}$$

63. If the function  $f(x)$  is differentiable at  $x = 1$ , then what is the value of  $(a + b)$ ?

- (a)  $-\frac{1}{3}$
- (b) -1
- (c) 0
- (d) 1

64. What is  $\lim_{x \rightarrow 0} f(x)$  equal to ?

- (a)  $-\frac{1}{3}$
- (b)  $-\frac{2}{3}$
- (c) 0
- (d) 1

65. If  $f(x) = |\ln|x||$  where  $0 < x < 1$ , then what is  $f'(0.5)$  equal to ?

- (a) -2
- (b) -1
- (c) 0
- (d) 2

66. If  $f'(x) = \cos(\ln x)$  and  $y = f\left(\frac{2x-3}{x}\right)$ , then what is  $\frac{dy}{dx}$  equal to ?

- (a)  $\cos\left(\ln\left(\frac{2x-3}{x}\right)\right)$
- (b)  $-\frac{3}{x^2} \sin\left(\ln\left(\frac{2x-3}{x}\right)\right)$
- (c)  $\frac{3}{x^2} \cos\left(\ln\left(\frac{2x-3}{x}\right)\right)$
- (d)  $-\frac{3}{x^2} \cos\left(\ln\left(\frac{2x-3}{x}\right)\right)$

67. What is  $\int_0^{8\pi} |\sin x| dx$  equal to ?

- (a) 2
- (b) 4
- (c) 8
- (d) 16

68. What is the area between the curve  $f(x) = x|x|$  and x-axis for  $x \in [-1, 1]$  ?

- (a)  $\frac{2}{3}$
- (b)  $\frac{1}{2}$
- (c)  $\frac{1}{4}$
- (d)  $\frac{1}{3}$

69. What are the order and the degree respectively of the differential equation

$$x^2 \left(\frac{d^3y}{dx^3}\right)^2 + \left(\frac{dy}{dx}\right)^4 + \sin x = 0 ?$$

- (a) 3, 4
- (b) 1, 4
- (c) 2, 2
- (d) 3, 2

70. What is the differential equation of all parabolas of the type  $y^2 = 4a(x-b)$  ?

- (a)  $\frac{d^2y}{dx^2} + \left(\frac{dy}{dx}\right)^2 = 0$
- (b)  $\frac{d^2y}{dx^2} + x^2 \left(\frac{dy}{dx}\right)^2 = 0$
- (c)  $y^2 \frac{d^2y}{dx^2} + \left(\frac{dy}{dx}\right)^2 = 0$
- (d)  $y \frac{d^2y}{dx^2} + \left(\frac{dy}{dx}\right)^2 = 0$

Consider the following for the next two (02) items that follow :

Let  $a_1, a_2, a_3 \dots$  be in AP such that

$$a_1 + a_5 + a_{10} + a_{15} + a_{20} + a_{25} + a_{30} + a_{34} = 300.$$

71. What is

$$a_1 + a_5 - a_{10} - a_{15} - a_{20} - a_{25} + a_{30} + a_{34}$$

equal to ?

- (a) 0
- (b) 25
- (c) 125
- (d) 250

72. What is  $\sum_{n=1}^{34} a_n$  equal to ?

- (a) 900
- (b) 1025
- (c) 1200
- (d) 1275

Consider the following for the next two (02) items that follow :

$$\text{Let } p = \cos\left(\frac{\pi}{5}\right)\cos\left(\frac{2\pi}{5}\right) \text{ and } q = \cos\left(\frac{4\pi}{5}\right)\cos\left(\frac{8\pi}{5}\right).$$

73. What is the value of  $p + q$  ?

- (a)  $-\frac{1}{2}$
- (b)  $-\frac{1}{4}$
- (c) 0
- (d)  $\frac{1}{2}$

74. What is the value of  $pq$  ?

- (a)  $-\frac{1}{16}$
- (b)  $-\frac{1}{4}$
- (c)  $\frac{1}{4}$
- (d)  $\frac{1}{16}$

Consider the following for the next two (02) items that follow :

$$\text{Let } p = \frac{1}{3} - \frac{\tan 3x}{\tan x} \text{ and}$$

$$q = 1 - 3 \tan^2 x, 0 < x < \pi, x \neq \frac{\pi}{2}.$$

75. What is  $pq$  equal to ?

- (a) 1
- (b) 2
- (c)  $\frac{8}{3}$
- (d)  $-\frac{8}{3}$

76. For how many values of  $x$  does  $\frac{1}{p}$  become zero ?

- (a) No value
- (b) Only one value
- (c) Only two values
- (d) Only three values

Consider the following for the next two (02) items that follow :

Let  $\sin x + \sin y = \sqrt{3}(\cos y - \cos x)$ ;  $x + y = \frac{\pi}{2}$ ,  
 $0 < x, y < \frac{\pi}{2}$ .

77. What is a value of  $\sin 3x + \sin 3y$  ?

- (a) -1
- (b) 0
- (c) 1
- (d) 3

78. What is a value of  $\cos^3 x + \cos^3 y$  ?

- (a)  $\frac{3\sqrt{3}}{8}$
- (b)  $\frac{3\sqrt{6}}{8}$
- (c)  $\frac{3\sqrt{6}}{4}$
- (d) 1

Consider the following for the next two (02) items that follow :

The angles A, B and C of a triangle ABC are in the ratio 3 : 5 : 4.

79. What is the value of  $a + b + \sqrt{2}c$  equal to ?

- (a) 3a
- (b) 2b
- (c) 3b
- (d) 2c

80. What is the ratio of  $a^2 : b^2 : c^2$  ?

- (a)  $2 : 2 + \sqrt{3} : 3$
- (b)  $2 : 2 - \sqrt{3} : 2$
- (c)  $2 : 2 + \sqrt{3} : 2$
- (d)  $2 : 2 - \sqrt{3} : 3$

81. What is the equation of directrix of parabola  $y^2 = 4bx$ , where  $b < 0$  and  $b^2 + b - 2 = 0$  ?

- (a)  $x + 1 = 0$
- (b)  $x - 2 = 0$
- (c)  $x - 1 = 0$
- (d)  $x + 2 = 0$

82. The points  $(-a, -b)$ ,  $(0, 0)$ ,  $(a, b)$  and  $(a^2, ab)$  are :

- (a) lying on the same circle
- (b) vertices of a square
- (c) vertices of a parallelogram that is not a square
- (d) collinear

83. Given that  $16p^2 + 49q^2 - 4r^2 - 56pq = 0$ . Which one of the following is a point on a pair of straight lines  $(px + qy + r)(px + qy - r) = 0$  ?

- (a)  $\left(2, \frac{7}{2}\right)$
- (b)  $\left(2, -\frac{7}{2}\right)$
- (c)  $(4, -7)$
- (d)  $(4, 7)$

84. If  $3x + y - 5 = 0$  is the equation of a chord of the circle  $x^2 + y^2 - 25 = 0$ , then what are the coordinates of the mid-point of the chord ?

- (a)  $\left(\frac{3}{4}, \frac{1}{4}\right)$
- (b)  $\left(\frac{3}{2}, \frac{1}{2}\right)$
- (c)  $\left(\frac{3}{4}, -\frac{1}{4}\right)$
- (d)  $\left(\frac{3}{2}, -\frac{1}{2}\right)$

85. Consider the following in respect of the equation  $\frac{x^2}{24-k} + \frac{y^2}{k-16} = 2$ .

1. The equation represents an ellipse if  $k = 19$ .
2. The equation represents a hyperbola if  $k = 12$ .
3. The equation represents a circle if  $k = 20$ .

How many of the statements given above are correct ?

- (a) Only one
- (b) Only two
- (c) All three
- (d) None

86. Consider the following statements in respect of hyperbola  $\frac{x^2}{\cos^2 \theta} - \frac{y^2}{\sin^2 \theta} = 1$  :

1. The two foci are independent of  $\theta$ .
2. The eccentricity is  $\sec \theta$ .
3. The distance between the two foci is 2 units.

How many of the statements given above are correct ?

- (a) Only one
- (b) Only two
- (c) All three
- (d) None

87. Consider the following in respect of the circle  $4x^2 + 4y^2 - 4ax - 4ay + a^2 = 0$  :

1. The circle touches both the axes.
2. The diameter of the circle is  $2a$ .
3. The centre of the circle lies on the line  $x + y = a$ .

How many of the statements given above are correct ?

- (a) Only one
- (b) Only two
- (c) All three
- (d) None

88. For what values of  $k$  is the line  $(k-3)x - (5-k^2)y + k^2 - 7k + 6 = 0$  parallel to the line  $x + y = 1$  ?

- (a)  $-1, 1$
- (b)  $-1, 2$
- (c)  $1, -2$
- (d)  $2, -2$

89. The line  $x + y = 4$  cuts the line joining  $P(-1, 1)$  and  $Q(5, 7)$  at  $R$ . What is  $PR : RQ$  equal to ?

- (a)  $1 : 1$
- (b)  $1 : 2$
- (c)  $2 : 1$
- (d)  $1 : 3$

90. What is the sum of the intercepts of the line whose perpendicular distance from origin is 4 units and the angle which the normal makes with positive direction of  $x$ -axis is  $15^\circ$  ?

- (a) 8
- (b)  $4\sqrt{6}$
- (c)  $8\sqrt{6}$
- (d) 16

91. What is the length of projection of the vector  $\hat{i} + 2\hat{j} + 3\hat{k}$  on the vector  $2\hat{i} + 3\hat{j} - 2\hat{k}$  ?

- (a)  $\frac{1}{\sqrt{17}}$   
 (b)  $\frac{2}{\sqrt{17}}$   
 (c)  $\frac{3}{\sqrt{17}}$   
 (d)  $\frac{2}{\sqrt{14}}$

92. If  $(\vec{a} \times \vec{b})^2 + (\vec{a} \cdot \vec{b})^2 = 144$  and  $|\vec{b}| = 4$ , then what is the value of  $|\vec{a}|$  ?

- (a) 3  
 (b) 4  
 (c) 5  
 (d) 6

93. If  $\theta$  is the angle between vectors  $\vec{a}$  and  $\vec{b}$  such that  $\vec{a} \cdot \vec{b} \geq 0$ , then which one of the following is correct ?

- (a)  $0 \leq \theta \leq \pi$   
 (b)  $\frac{\pi}{2} \leq \theta \leq \pi$   
 (c)  $0 \leq \theta \leq \frac{\pi}{2}$   
 (d)  $0 < \theta < \frac{\pi}{2}$

94. The vectors  $60\hat{i} + 3\hat{j}$ ,  $40\hat{i} - 8\hat{j}$  and  $\beta\hat{i} - 52\hat{j}$  are collinear if :

- (a)  $\beta = 20$   
 (b)  $\beta = 40$   
 (c)  $\beta = -40$   
 (d)  $\beta = 26$

95. Consider the following in respect of the vectors  $\vec{a} = (0, 1, 1)$  and  $\vec{b} = (1, 0, 1)$  :

- The number of unit vectors perpendicular to both  $\vec{a}$  and  $\vec{b}$  is only one.
- The angle between the vectors is  $\frac{\pi}{3}$ .

Which of the statements given above is/are correct ?

- (a) 1 only  
 (b) 2 only  
 (c) Both 1 and 2  
 (d) Neither 1 nor 2

96. If L is the line with direction ratios  $\langle 3, -2, 6 \rangle$  and passing through  $(1, -1, 1)$ , then what are the coordinates of the points on L whose distance from  $(1, -1, 1)$  is 2 units ?

- (a)  $\left(-\frac{11}{7}, \frac{13}{7}, \frac{19}{7}\right)$  and  $\left(\frac{1}{7}, \frac{3}{7}, \frac{5}{7}\right)$   
 (b)  $\left(\frac{19}{7}, -\frac{11}{7}, \frac{13}{7}\right)$  and  $\left(-\frac{1}{7}, \frac{3}{7}, -\frac{5}{7}\right)$   
 (c)  $\left(\frac{13}{7}, \frac{11}{7}, \frac{19}{7}\right)$  and  $\left(-\frac{1}{7}, -\frac{3}{7}, \frac{5}{7}\right)$   
 (d)  $\left(\frac{13}{7}, -\frac{11}{7}, \frac{19}{7}\right)$  and  $\left(\frac{1}{7}, -\frac{3}{7}, -\frac{5}{7}\right)$

97. Which one of the planes is parallel to the line  $\frac{x-2}{3} = \frac{y-3}{4} = \frac{z-4}{5}$  ?
- (a)  $2x + 2y + z - 1 = 0$   
 (b)  $2x - y - 2z + 5 = 0$   
 (c)  $2x + 2y - 2z + 1 = 0$   
 (d)  $x - 2y + z - 1 = 0$
98. What is the angle between the lines  $2x = 3y = -z$  and  $6x = -y = -4z$  ?
- (a)  $0^\circ$   
 (b)  $30^\circ$   
 (c)  $60^\circ$   
 (d)  $90^\circ$
99. What is the equation of the sphere concentric with the sphere  $x^2 + y^2 + z^2 - 2x - 6y - 8z - 5 = 0$  and which passes through the origin ?
- (a)  $x^2 + y^2 + z^2 - 2x - 8z = 0$   
 (b)  $x^2 + y^2 + z^2 - 2x - 6y = 0$   
 (c)  $x^2 + y^2 + z^2 - 6y - 8z = 0$   
 (d)  $x^2 + y^2 + z^2 - 2x - 6y - 8z = 0$
100. A point P lies on the line joining A(1, 2, 3) and B(2, 10, 1). If z-coordinate of P is 7, what is the sum of other two coordinates ?
- (a) -15  
 (b) -13  
 (c) -11  
 (d) -9
101. The sum of deviations of n numbers from 10 and 20 are p and q respectively. If  $(p - q)^2 = 10000$ , then what is the value of n ?
- (a) 10  
 (b) 20  
 (c) 50  
 (d) 100
102. If  $\bar{X} = 20$  is the mean of 10 observations  $x_1, x_2, \dots, x_{10}$ ; then what is the value of  $\sum_{i=1}^{10} \left( \frac{3x_i - 4}{5} \right)^2$  ?
- (a) 0  
 (b) 12  
 (c) 112  
 (d) 1012
103. If the mean and the sum of squares of 10 observations are 40 and 16160 respectively, then what is the standard deviation ?
- (a) 16  
 (b) 6  
 (c) 5  
 (d) 4
104. Three dice are thrown. What is the probability of getting a sum which is a perfect square ?
- (a)  $\frac{17}{108}$   
 (b)  $\frac{5}{108}$   
 (c)  $\frac{19}{108}$   
 (d)  $\frac{23}{108}$

105. A, B, C and D are mutually exclusive and exhaustive events.  
If  $2P(A) = 3P(B) = 4P(C) = 5P(D)$ ,  
then what is  $77P(A)$  equal to ?
- (a) 12  
(b) 15  
(c) 20  
(d) 30
106. Two distinct natural numbers from 1 to 9 are picked at random. What is the probability that their product has 1 in its unit place ?
- (a)  $\frac{1}{81}$   
(b)  $\frac{1}{72}$   
(c)  $\frac{1}{18}$   
(d)  $\frac{1}{36}$
107. Two dice are thrown. What is the probability that difference of numbers on them is 2 or 3 ?
- (a)  $\frac{7}{36}$   
(b)  $\frac{7}{18}$   
(c)  $\frac{5}{18}$   
(d)  $\frac{11}{36}$
108. What is the mean of the numbers 1, 2, 3, ..., 10 with frequencies  ${}^9C_0, {}^9C_1, {}^9C_2, \dots, {}^9C_9$ , respectively ?
- (a)  $1.1 \times 2^8$   
(b)  $1.2 \times 7^4$   
(c) 5.5  
(d) 0.55
109. The probability that a person recovers from a disease is 0.8. What is the probability that exactly 2 persons out of 5 will recover from the disease ?
- (a) 0.00512  
(b) 0.02048  
(c) 0.2048  
(d) 0.0512
110. Suppose that there is a chance for a newly constructed building to collapse, whether the design is faulty or not. The chance that the design is faulty is 10%. The chance that the building collapses is 95% if the design is faulty, otherwise it is 45%. If it is seen that the building has collapsed, then what is the probability that it is due to faulty design ?
- (a) 0.10  
(b) 0.19  
(c) 0.45  
(d) 0.95

111. If  $r$  is the coefficient of correlation between  $x$  and  $y$ , then what is the correlation coefficient between  $(3x + 4)$  and  $(-3y + 3)$ ?

- (a)  $-r$
- (b)  $r$
- (c)  $\sqrt{3}r$
- (d)  $-\sqrt{3}r$

112. A fair coin is tossed 6 times. What is the probability of getting a result in the 6<sup>th</sup> toss which is different from those obtained in the first five tosses?

- (a)  $\frac{7}{16}$
- (b)  $\frac{1}{16}$
- (c)  $\frac{1}{32}$
- (d)  $\frac{1}{64}$

113. If  $H$  is the Harmonic Mean of three numbers  ${}^{10}C_4$ ,  ${}^{10}C_5$ , and  ${}^{10}C_6$ , then what is the value of  $\frac{270}{H}$ ?

- (a) 1
- (b)  $\frac{14}{17}$
- (c)  $\frac{17}{14}$
- (d)  $\frac{1}{31}$

114. In a class, there are  $n$  students including the students  $P$  and  $Q$ . What is the probability that  $P$  and  $Q$  sit together if seats are assigned randomly?

- (a)  $\frac{1}{n}$
- (b)  $\frac{2}{n}$
- (c)  $\frac{4}{n}$
- (d)  $\frac{1}{2n}$

115. In a Binomial distribution  $B(n, p)$ ,  $n = 6$  and  $9P(X = 4) = P(X = 2)$ . What is  $p$  equal to?

- (a)  $\frac{1}{4}$
- (b)  $\frac{1}{2}$
- (c)  $\frac{3}{4}$
- (d)  $\frac{4}{5}$

Consider the following for the next five (05) items that follow :

Three boys P, Q, R and three girls S, T, U are to be arranged in a row for a group photograph.

116. What is the probability that all three boys sit together ?

- (a)  $\frac{1}{5}$
- (b)  $\frac{1}{4}$
- (c)  $\frac{1}{3}$
- (d)  $\frac{1}{12}$

117. What is the probability that boys and girls sit alternatively ?

- (a)  $\frac{4}{5}$
- (b)  $\frac{1}{10}$
- (c)  $\frac{5}{6}$
- (d)  $\frac{1}{7}$

118. What is the probability that no two girls sit together ?

- (a)  $\frac{2}{5}$
- (b)  $\frac{3}{5}$
- (c)  $\frac{1}{18}$
- (d)  $\frac{1}{5}$

119. What is the probability that P and Q take the two end positions ?

- (a)  $\frac{1}{15}$
- (b)  $\frac{7}{15}$
- (c)  $\frac{14}{15}$
- (d)  $\frac{11}{45}$

120. What is the probability that Q and U sit together ?

- (a)  $\frac{2}{3}$
- (b)  $\frac{1}{4}$
- (c)  $\frac{5}{6}$
- (d)  $\frac{1}{3}$

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