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1. What is the value of k such that the two vectors $v = (1, k, -3)$ and $w = (2, -5, 4)$ are orthogonal?

- ☐ A. 2
- ☐ B. 5
- ☐ C. -2
- ☐ D. 5

2. What is equation of a line passing through the point $P=(2,1)$ in the direction of vector $A=(-1,5)$?

☐ A. $y=-5x+11$

☐ B. $y=5x-11$

☐ C. $x+5y=11$

☐ D. $x-5y=-11$

3. Consider the matrices

$$A = (1, 0, 0)$$

and $B =$

$$B = \begin{pmatrix} 3 & 1 & 5 \\ 2 & 0 & 1 \\ 1 & 1 & 7 \end{pmatrix}$$

The multiplication of the matrices AB is equal to:

A)

$$\begin{pmatrix} 3 & 1 \\ 2 & 0 \\ 1 & 1 \end{pmatrix}$$

B)

$$\begin{pmatrix} 3 & 1 & 5 \\ 2 & 0 & 1 \end{pmatrix}$$

C)

$$(3, 1, 5)$$

D)

$$\begin{pmatrix} 3 & 1 & 5 \\ 2 & 0 & 1 \\ 1 & 1 & 7 \end{pmatrix}$$



D)

$$\begin{pmatrix} 3 & 1 & 5 \\ 2 & 0 & 1 \\ 1 & 1 & 7 \end{pmatrix}$$

- ☐ A. A is correct
- ☐ B. B is correct
- ☐ C. C is correct
- ☐ D. D is correct

4. Let

$$A = \begin{pmatrix} 1 & 2 \\ 4 & -3 \end{pmatrix}$$

and let

$$f(x) = x^2 + 2x - 11$$

. Then the matrix

$$f(A)$$

is equal to

A)

$$\begin{pmatrix} 0 & 0 \\ 0 & 0 \end{pmatrix}$$

B)

$$\begin{pmatrix} 11 & 0 \\ 0 & 11 \end{pmatrix}$$

C)

$$\begin{pmatrix} -11 & 0 \\ 0 & -11 \end{pmatrix}$$

D)

$$\begin{pmatrix} 0 & 11 \\ 11 & 0 \end{pmatrix}$$



☐ A. A is correct

☐ B. B is correct

☐ C. C is correct

☐ D. D is correct

5. Suppose

$$A = \begin{pmatrix} 4 & x + 2 \\ 2x - 3 & x + 1 \end{pmatrix}$$

**is symmetric. Then the value
of
 x
is**

☐ A. 4

☐ B. 5

☐ C. -5

☐ D. -4

6. What is the solution of system of linear equations

$$\begin{cases} 2x - 3y + 3z = -8 \\ 3x + 2y + 2z = 10 \\ x - y - 2z = 1 \end{cases}$$

?

A. $x=2, y=3$

$$x = 2, y = 3$$

and $z=-1$

$$z = -1$$

C) $x=2, y=0$

$$x = 2, y = 0$$

and $z=-4$

$$z = -4$$

B. $x=-2, y=-3$

$$x = -2, y = -3$$

and $z=1$

$$z = 1$$



D) $x=4, y=1$

$x = 4, y = 1$

and $z=1$

$z = 1$

- ☐ A. A is correct
- ☐ B. B is correct
- ☐ C. C is correct
- ☐ D. D is correct



7. Let

$$T: \mathbb{R}^2 \rightarrow \mathbb{R}$$

be a linear transformation defined as

$$T(x, y) = x + 3y$$

. Then, basis of kernel of T is

A.

$$\{(-3, 1)\}$$

B)

$$\{(0, 1)\}$$

C)

$$\{(3, -1)\}$$

D)

$$\{(0, -1)\}$$

☐ A. A is correct

☐ B. B is correct

☐ C. C is correct

☐ D. D is correct



8. The *is*

$\gcd(3a + 5, 7a + 12)$ is

☐ A. 2

☐ B. 3

☐ C. 1

☐ D. 5

10. The complete Solutions of linear congruence *is*.

$$16x \equiv 8(\text{mod. } 28) \text{ is.}$$

A.

$$\{4, 11, 18, 25\}$$

B. $\{4\}$

C.

$$\{4, 7\}$$

D. $\{4, 9, 14\}$

☐ A. A is correct

☐ B. B is correct

☐ C. C is correct

☐ D. D is correct

11. . ----- the remainder
when 3164 is divided by 68.

☐ A. 23

☐ B. 13

☐ C. 28

☐ D. 2

12. Which one of the following is **true** about decimal expansion of $\frac{1}{6}$?

- ☐ A. It is purely periodic
- ☐ B. The length of expansion 2
- ☐ C. It is a finite decimal expansion
- ☐ D. It is not purely periodic

13. The continued fraction

$$2 + \frac{1}{3 + \frac{1}{4 + \frac{1}{5}}}$$

is equal to

- ☐ A. A. $21/68$
- ☐ B. B. $21/5$
- ☐ C. C. $157/68$
- ☐ D. D. $21/157$

14. If

$$2^4 \times 5^2$$

is the prime factorization of 400, then the number of positive factors of

$\tau(400)$ is _____.

- ☐ A. 12
- ☐ B. 465
- ☐ C. 15
- ☐ D. 961

15. If x is an element of a group then $x \circ (x)$ is equal to:

☐ A. x

☐ B. e

☐ C. x^{-1}

☐ D. x^2 E. x^3

16. Let a, b be elements of a group. If $a^5 = e, aba^{-1} = b^2, b \neq e$, then $o(b)$ is equal to:

☐ A. 5

☐ B. 2

☐ C. 16

☐ D. 31

17. The value of x in S_9 for the equation $(123)x = (345678)$ is equal to:

- ☐ A. $.(12345678)$
- ☐ B. $.(16782345)$
- ☐ C. $.(28765431)$
- ☐ D. $.(13456782)$

18. Let $x_1, x_2, \dots, x_{20}$ be all the distinct orbits under the action of a group over a finite set S and $|x_i|$ is equal to $\beta + \delta_i \forall i$. If $|x_6| + |x_{15}| = 10$, then $|S|$ is equal to:

- ☐ A. 15
- ☐ B. 25
- ☐ C. 30
- ☐ D. 100

19. As normality is to group theory, ——— is to ring theory.

- ☐ A. locality
- ☐ B. subring ness
- ☐ C. subset ness
- ☐ D. ideality

20. Let I, J be ideals of R such that

$$J \subseteq I. \text{ If } g : \frac{R}{J} \longrightarrow \frac{R}{I}$$

defined as $g(J + r) = I + r$, then

ker g is equal to:

A. R B. $\frac{J}{I}$

$$\frac{J}{I}$$

C. $\frac{J+I}{J}$

$$\frac{J+I}{J}$$

D. $\frac{I}{J}$

$$\frac{I}{J}$$

☐ A. A is correct

☐ B. B is correct

☐ C. C is correct

☐ D. D is correct

21.If $\mathbb{Q}(\omega)$ is the splitting field of $x^3 - 1$ over $\mathbb{Q}$, the splitting field of $(x - 1)^3 + 8$ over $\mathbb{Q}$ is equal to:

- ☐ A. $\mathbb{Q}(1 - 2\omega^2)$
- ☐ B. $\mathbb{Q}(1 - 2\omega)$
- ☐ C. $\mathbb{Q}(1 - \omega^2)$
- ☐ D. $\mathbb{Q}(1 - \omega)$

22.

$$\lim_{x \rightarrow 1^-} \frac{x^2 + 1}{x^2 - 1} =$$

A.

∞

B.

$-\infty$

C. 1

D.

. ~~A~~

☐ A. A is correct

☐ B. B is correct

☐ C. C is correct

☐ D. D is correct

23. For what value(s) of k be the function

$$f(x) = \begin{cases} kx^2 & \text{if } x \leq 2 \\ 2x + k & \text{if } x > 2 \end{cases}$$

be continuous everywhere?

☐ A. $2/3$

☐ B. $4/3$

☐ C. $3/2$

☐ D. $3/4$

24. Which of the following is not true about

$$f(x) = x^4 - 6x^2 + 8x + 10$$

- ☐ A. $f(x)$ concave up ward on $(-\infty, -1) \cup (1, \infty)$
- ☐ B. $(-1, -3)$ and $(1, 13)$ are inflection point.
- ☐ C. $f(x)$ concave down ward on $(-1, 1)$
- ☐ D. $X = -1$ is a critical number

- ✓ 25. Suppose that a liquid is to be cleared of sediment by pouring it through a conical filter that is 16cm high and has a radius of 4cm at the top. If the liquid flows out of the cone at a constant rate of $2\text{cm}^2/\text{min}$, at what rate is the depth of the liquid changing when the liquid level is 8cm?

- ☐ A. $1/2\pi$ cm/min
- ☐ B. 2π cm/min
- ☐ C. $-1/2\pi$ cm/min
- ☐ D. -2π cm/min

26.

$$\int_1^2 \frac{x}{x^2 + 1} dx = \underline{\hspace{2cm}}$$

☐ A. $\ln\sqrt{2}$

☐ B. $\ln 4$

☐ C. $\ln 2$

☐ D. $\ln 8$

27.

$$\frac{d}{dx} \int_0^x \frac{1}{1+t^2} dx = \underline{\hspace{2cm}}$$

☐ A. $1/(1+t^2)$

☐ B. $1/(1+x^2)$

☐ C. $1+x^2$

☐ D. $1+t^2$

28.

$$\int_{-\infty}^{\infty} \frac{1}{1+x^2} dx = \underline{\hspace{2cm}}$$

☐ A. π

☐ B. $\pi/(2)$

☐ C. $-\pi/(2)$

☐ D. $-\pi$

29. The area of the region enclosed between

$$f(x) = 2 - x^2$$

and

$$g(x) = -x$$

is

- ☐ A. $9/2$
- ☐ B. $27/2$
- ☐ C. $8/3$
- ☐ D. 8

30. The volume of the solid
when the curve

$$y = \sqrt{x}$$

revolve about an x-axis on an
interval $[1, 4]$ is _____ cubic
unit

- ☐ A. $20/3$
- ☐ B. 10
- ☐ C. $15/2$
- ☐ D. 30

31. Which of the following is false?

- ☐ A. A function has an inverse if and only if it is one to one function
- ☐ B. Both increasing and decreasing functions have an inverse
- ☐ C. C) The domain of function is the range of its inverse
- ☐ D. In the set of real numbers, the inverse of the function, $f(x)=x^2$ is $f^{-1}(x)=\sqrt{x}$.

32. If

$a > 0$ and u

is differentiable function of x ,

then what is ?

$$\frac{d}{dx} (\log_a u) ?$$

A) $\frac{a^u}{\ln a}$

b.

$a^u \ln a$

C)

$a^u \ln a \frac{du}{dx}$

D)

$\frac{1}{u \ln a} \frac{du}{dx}$

☐ A. A is correct

☐ B. B is correct

☐ C. C is correct

☐ D. D is correct



33.

$$\frac{d}{dx}(\tan^{-1}(\sqrt{x}))$$

is

A) $\frac{-1}{1+x^2}$

B)

$$\frac{-1}{\sqrt{1-x^2}}$$

C)

$$\frac{1}{2\sqrt{x}(1+x)}$$

D)

$$\frac{1}{\sqrt{1-x^2}}$$

☐ A. A is correct

☐ B. B is correct

☐ C. C is correct

☐ D. D is correct

34.

$$\int \frac{dx}{\sqrt{8x-x^2}}$$

is

A) $\sin^{-1} \left(\frac{x-4}{4} \right) + c$

B)

$$\csc^{-1} \left(\frac{x}{4} \right) + c$$

C)

$$\tan^{-1} \left(\frac{x+4}{4} \right) + c$$

D)

$$\cos^{-1} \left(\frac{x}{4} \right) + c$$

☐ A. A is correct

☐ B. B is correct

☐ C. C is correct

☐ D. D is correct

35. To evaluate, $e^x \cos x$,

$$\int e^x \cos x,$$

which of the following techniques of integration is suitable?

- ☐ A. A) Integration by substitution
- ☐ B. B) Integration by parts
- ☐ C. Tabular integration
- ☐ D. B and C are answers

36.

$$\int_1^{\infty} \frac{\ln x}{x^2} dx$$

is

☐ A. 0

☐ B. 0.5

☐ C. 1

☐ D. ∞

37. What is the left hand limit,

$$\lim_{x \rightarrow \left(\frac{\pi}{2}\right)^-} (\sec x - \tan x) ?$$

☐ A. 0

☐ B. 1

☐ C. 2

☐ D. ∞

38. Which of the following series is NOT convergent?

A.

$$\sum_{n=1}^{\infty} \frac{1}{\sqrt{n}}$$

B)

$$\sum_{n=1}^{\infty} \frac{1}{n^2 + 1}$$

C)

$$\sum_{n=1}^{\infty} \frac{(-1)^n n^4}{3^n}$$

D)

$$\sum_{n=1}^{\infty} \frac{n!}{n^n}$$

☐ A. A is correct

☐ B. B is correct

☐ C. C is correct

☐ D. D is correct

39. What is the radius of convergence of the power series

$$\sum_{n=1}^{\infty} \frac{(-1)^n n^2 x^n}{2^n} ?$$

☐ A. $R=0.5$

☐ B. $R=1$

☐ C. $R=2$

☐ D. $R=3$

40. What is a unit tangent vector to the circular helix given by a vector function?

$$r(t) = \cos t \, i + \sin t \, j + t \, k$$

.

- ☐ A. $\sin t \, i + \cos t \, j$
- ☐ B. $\cos t \, j - \sin t \, i$
- ☐ C. $\cos t \, i + \sin t \, k$
- ☐ D. $\cos t \, i - \sin t \, j$

41. Let

$$f(x, y) = \sqrt{x^2 - xy}$$

. Then the gradient

$$\nabla f(2, 0)$$

?

☐ A. $i - j$

☐ B. $i + j$

☐ C. $i - j/2$

☐ D. $4i - 2j$

42. Let

$$w = \ln \sqrt{xyz}$$

then the total differential
 dw

is given by?

A)

$$\frac{dx}{2x} + \frac{dy}{2y} + \frac{dz}{2z}$$

B)

$$\frac{yz}{2\sqrt{xyz}} dx + \frac{xz}{2\sqrt{xyz}} dy + \frac{yx}{2\sqrt{xyz}} dz$$

C)

$$\frac{dx}{\sqrt{xyz}} + \frac{dy}{\sqrt{xyz}} + \frac{dz}{\sqrt{xyz}}$$

D) None of the Above

☐ A. A is correct

☐ B. B is correct

☐ C. C is correct

☐ D. D is correct

43. Which one is not the critical point of the function

$$f(x,y) = 3x^2y + y^3 - 3x^2 - 3y^2 + 2$$

☐ A. (0,0)

☐ B. (1,1)

☐ C. (0,2)

☐ D. (1,-1)

44. Let

$$Z = e^x \sin y, \text{ where } x = st^2 \text{ and } y = s^2t$$

then

$$\frac{\partial z}{\partial s} = ?$$

A)

$$te^{st^2} (t \sin s^2 t + 2s \cos s^2 t)$$

B)

$$(st)^2 \sin s^2 t + 2st \cos s^2 t$$

C)

$$e^{st^2} t \sin s^2 t + 2e^{st^2} \cos s^2 t$$

D) None of the Above

☐ A. A is correct

☐ B. B is correct

☐ C. C is correct

☐ D. D is correct



45. R is the region of
 xy

plane bounded by the curves
 $y = y_1(x), y = y_2(x)$
and the line

$x = a$ and $x = b$.

Where ;
 $a \leq x \leq b$ and $y_1 \leq y \leq y_2$;

Then

$$\iint_R f(x, y) dA$$

=?

A)

$$\int_{y_1(x)}^{y_2(x)} \int_a^b f(x, y) dy dx$$

B)

$$\int_a^b \int_{y_1(x)}^{y_2(x)} f(x, y) dy dx$$

C)

$$\int_a^b \int_{y_1(x)}^{y_2(x)} f(x, y) dx dy$$

D)



D)

$$\int_a^b \int_1^2 f(x, y) \, dy \, dx$$

- ☐ A. A is correct
- ☐ B. B is correct
- ☐ C. C is correct
- ☐ D. D is correct

46.

$$\iint_R dx dy$$

represents

- ☐ A. Area of the region R in Cartesian coordinates
- ☐ B. Area of the region in polar coordinates
- ☐ C. Volume
- ☐ D. Surface of revolution



47. Which of the following integral relations over the same region D is true?

A)

$$\iint f(x, y) \, dx \, dy =$$

$$\iint f(r \cos \theta, r \sin \theta) \, d\theta \, dr$$

B)

$$\iint f(x, y) \, dx \, dy =$$

$$\iint f(r \sin \theta, r \cos \theta) \, d\theta \, dr$$

C)

$$\iint f(x, y) \, dx \, dy = \iint f(r \cos \theta, r \sin \theta) \, r \, d\theta \, dr$$

D)

$$\iint f(x, y) \, dx \, dy = \iint f(r \cos \theta, r \sin \theta) \, r^2 \, d\theta \, dr$$

☐ A. A is correct

☐ B. B is correct

☐ C. C is correct

☐ D. D is correct



48. The value of

$$\iint \sin \pi(x^2 + y^2) dx dy$$

, over the circular region

$$x^2 + y^2 \leq 1$$

☐ A. $1/\pi$

☐ B. π

☐ C. 2π

☐ D. 2

49. Suppose that (a,b) be the stationary point of the function $f(x,y)$, next define

$$D(a,b) = [f_{xx}f_{yy}](a,b) - [f_{xy}(a,b)]^2$$

then which of the following is correct

- ☐ A. If $D(a,b) > 0$ and $f_{xx} > 0$ then $f(a,b)$ is the relative maximum
- ☐ B. If $D(a,b) > 0$ and $f_{yy} < 0$ then $f(a,b)$ is the relative minimum.
- ☐ C. If $D(a,b) < 0$ then the critical point (a,b) is called the saddle point.
- ☐ D. all are correct

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☐ C. 2π

☐ D. 2

^

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- ☐ C. If $D(a,b) < 0$ then the critical point (a,b) is called the saddle point.
- ☐ D. all are correct



50. Which one of the following is not true?

- ☐ A. Principal argument of $x > 0$, is zero
- ☐ B. Principal argument of $x < 0$, is π
- ☐ C. Principal argument of $2i$, is $\pi/2$
- ☐ D. Principal argument of $-2i$, is $\pi/2$

^ 51. Let the function

$$f(z) = \frac{1-i}{1+i}$$

, which one is not true about $f(z)$?

A.

$$\frac{1-i}{1+i} = -i$$

B) Principal argument of

$$\frac{1-i}{1+i}$$

, is $-\pi/2$

$$-\frac{\pi}{2}$$

C)

$$\left| \frac{1-i}{1+i} \right| = 1$$



C)

$$\left| \frac{1-i}{1+i} \right| = 1$$

D) none of the above

☐ A. A is correct

☐ B. B is correct

☐ C. C is correct

☐ D. D is correct

^ 52. Which one of the following is not true?

A)

$$|z_1 - z_2| \geq |z_1| - |z_2|$$

B)

$$|z_1 + z_2| \leq |z_1| + |z_2|$$

C)

$$|z_1 - z_2| \leq |z_1| + |z_2|$$

d) none

☐ A. A is correct

☐ B. B is correct

☐ C. C is correct

☐ D. D is correct



53. The analytic function whose real part is $e^x \cos y$

$$e^x \cos y$$

where

$$z = x + iy$$

is

☐ A. $e^z + ci$

☐ B. e^{2z}

☐ C. $[xe]^z$

☐ D. NONE

54. The radius of convergence of the series

$$\sum_{n=1}^{\infty} \frac{n}{2^n} z^n$$

is

- ☐ A. 2
- ☐ B. 1
- ☐ C. ∞
- ☐ D. none

55. If C is a circle

$$|z - z_0| = r$$

, then

$$\int_C \frac{dz}{z - a}$$

is

☐ A. $2\pi i$

☐ B. $-2\pi i$

☐ C. πi

☐ D. 0

56. Which one of the following function does represent the series

$$\sum_{n=0}^{\infty} \frac{z^n}{n!}$$

for $z < \infty$

$$|z| < \infty$$

- ☐ A. $\sin z$
- ☐ B. $\cos z$
- ☐ C. e^z
- ☐ D. $\log(1+z)$

57.

$$\int_0^{\infty} \frac{dx}{1+x^2}$$

- ☐ A. 0
- ☐ B. 1
- ☐ C. $\pi/2$
- ☐ D. none

58.If

$$f(z) = \frac{e^z}{z^2(z^2+9)}$$

, then the residue of

$f(z)$

at

$$z = 0$$

is

- ☐ A. 1
- ☐ B. 1/9
- ☐ C. 2/3
- ☐ D. none

59. Given a Cauchy problem

$$u_t = xu_x - u + 1, x \in \mathbb{R}, t \geq 0$$

.

$$u(x, 0) = \sin x, x \in \mathbb{R}.$$

which one of the following is **true** about the solution of the given problem?

☐ A. The solution is $u = -1 - e^{-t}$ when $x = 0$

☐ B. The solution is $u = 1 + e^{-t}$ when $x = 0$

☐ C. As t approaches to ∞ the solution approaches to the value



○D. As t approaches to ∞ the solution approaches to the value -1

73. The iterative formula to find the root of the equation

$$f(x) = 3x^2 - 2x + 1 = 0$$

by the Newton's Raphson method is

-----.

A.

$$x_{n+1} = \frac{3x_n^2 + 1}{6x_n - 2}$$

C)

$$x_{n+1} = \frac{3x_n^2 - 2x_n + 1}{6x_n - 2}$$

B.

$$x_{n+1} = \frac{3x_n^2 - 1}{6x_n - 2}$$

D)

$$x_{n+1} = \frac{x_n^2 - 1}{6x_n - 2}$$



☐ A. A is correct

☐ B. B is correct

☐ C. C is correct

☐ D. D is correct

60. Which one of the following is **not true** about the equation where

$$x \neq 0$$

and

$$y > 0$$

?

- ☐ A. The equation is parabolic for all x and y on the line $y=x$.
- ☐ B. The equation is elliptic for all x and y in the region $y < x$.
- ☐ C. The equation is hyperbolic for all x and y in the region $y > x$.
- ☐ D. The equation not a linear equation.



61 The order of the differential equation

$$(u_x)^4 + u_{xtx} - u_{tt} = 1$$

is

- ☐ A. one
- ☐ B. two
- ☐ C. tree
- ☐ D. four

^

62. What is the 9th term in the Fourier Sine Series expansion of the function f

$$f(x) = x$$

in the interval

$$0 < x < 3$$

?

A.

$$\frac{2}{3\pi} \sin 3\pi x$$

B.

$$\frac{6}{\pi} \sin \frac{\pi x}{3}$$

C.

$$\frac{-3}{\pi} \sin \frac{2\pi x}{3}$$

D.

$$-\frac{1}{\pi} \sin 2\pi x$$



- ☐ A. A is correct
- ☐ B. B is correct
- ☐ C. C is correct
- ☐ D. D is correct

63. Which one of the following statement is **not correct** about Fourier Transform?

- ☐ A. A. The Fourier Transform operator is a linear operator
- ☐ B. B. Every functions have a Fourier Transform
- ☐ C. C. The Fourier Transform and its inverse are both defined over the interval $(-\infty, \infty)$.
- ☐ D. D. The Fourier transform of a time derivative equals the time derivative of the Fourier transform