

FE - EXAM : MATHEMATICS

- ① ANALYTIC GEOMETRY + TRIGONOMETRY
- ② ALGEBRA + LINEAR ALGEBRA
- ③ PROBABILITY + STATISTICS
- ④ CALCULUS
- ⑤ DIFFERENTIAL EQUATIONS
+ TRANSFORMS

1. Which of the following lines is parallel to a line with the equation $y = \frac{1}{4}x + 6$?

(A) $y = -\frac{1}{4}x - 6$

(B) $y = -\frac{1}{4}x + 6$

(C) $y = 2x - 3$

(D) $x = 4y - 3$

2. What is the value of θ (less than 2π) that will satisfy the following equation?

$$\sin^2\theta + 4\sin\theta + 3 = 0$$

(A) $\frac{\pi}{4}$.

(B) $\frac{\pi}{2}$.

(C) π .

(D) $\frac{3\pi}{2}$.

3. What are the coordinates of the center and the radius, respectively, of the following equation for a circle?

$$x^2 + y^2 + 12y - 2x + 12 = 0$$

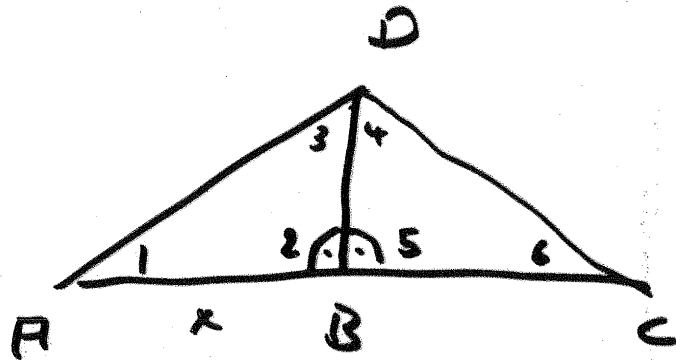
- (A) $(1, -6)$; 12.
- (B) $(-1, 6)$; $\sqrt{12}$.
- (C) $(-1, 6)$; 25
- (D) $(1, -6)$; 5

4. What are the x - and y -coordinates of the focus of the conic section described by the following equation? (Angle α corresponds to a right triangle with adjacent side x , opposite side y , and hypotenuse r .)

$$\sqrt{1 - \sin^2 \alpha} = \cos \alpha$$

- (A) $\left(-\frac{1}{2}, 0\right)$
- (B) $(0, 0)$
- (C) $\left(0, \frac{\pi}{2}\right)$
- (D) $\left(\frac{1}{4}, 0\right)$

5. In the following illustration, angles 2 and 5 are 90° , $AD = 15$, $DC = 20$, and $AC = 25$. What are the lengths BC and BD , respectively?



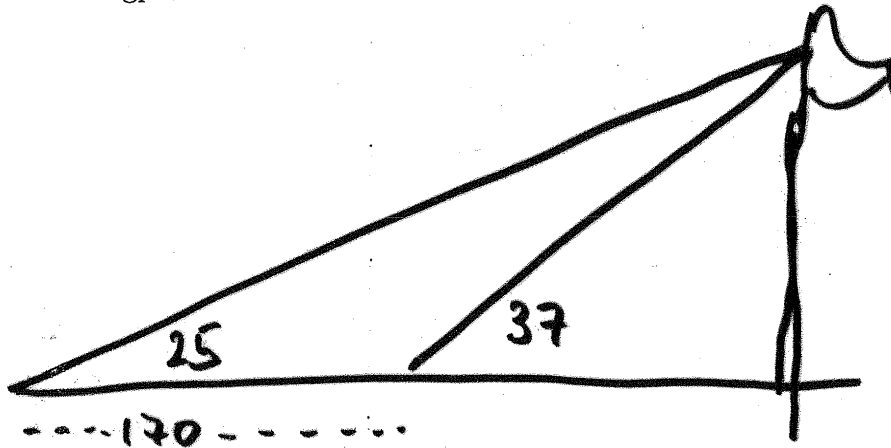
(A) 12, 16

(B) 16, 12

(C) 13, 17

(D) 18, 13

6. The vertical angle to the top of a flagpole from point A on the ground is observed to be $37^{\circ}11'$. The observer walks 170 ft directly away from point A and the flagpole to point B and find the new angle to be $25^{\circ}43'$. What is the approximate height of the flagpole?



(A) 10 ft

(B) 82 ft

(C) 220 ft

(D) 300 ft

Algebra and Linear Algebra

7. Which of the following numbers is equal to $\log_8(50)$?

(A) 0

(B) 0.53

(C) 0.79

(D) 1.88

8. What value of A satisfies the expression $A^{-6/8} = 0.001$?

(A) 0

(B) 100

(C) 1000

(D) 10,000

9. What is the polar form of the complex number $z = 3 + 4i$?

(A) $(3)(\cos 36.87^\circ + i \sin 36.87^\circ)$

(B) $(3)(\cos 53.15^\circ + i \sin 36.87^\circ)$

(C) $(4)(\cos 53.15^\circ + \sin 53.15^\circ)$

(D) $(5)(\cos 53.13^\circ + i \sin 53.13^\circ)$

10. What are the polar (r, θ) coordinates of the point that has rectangular (x, y) coordinates of $(4, 6)$?

(A) $(4, 6^\circ)$

(B) $(4, 56.3^\circ)$

(C) $(7.21, 33.7^\circ)$

(D) $(7.21, 56.3^\circ)$

11. Which of the following choices is closest to the rationalized form of complex number.

$$\frac{7 + j5.2}{3 + j4}$$

(A) $-0.030 + j1.8$

(B) $1.67 - j0.5$

(C) $2.33 + j1.2$

(D) $2.33 + j1.3$

12. What is the determinant of the following matrix?

$$A = \begin{bmatrix} 2 & 3 & 4 \\ 5 & 6 & 7 \\ 7 & 8 & 9 \end{bmatrix}$$

(A) -8

(B) -4

(C) 0

(D) 4

13. Problems A and B refer to the vectors A and B .

$$A = 2i + 4j + 8k$$

$$B = -2i + j - 4k$$

(A) What is the dot product, $A \cdot B$, of the vectors?

(A) $-4i + 4j - 32k$

(B) $-4i - 4j - 32k$

(C) -40

(D) -32

(B) What is the cross product, $A \times B$, of the vectors?

(A) $-24i - 8j + 10k$

(B) $-24i + 8j + 10k$

(C) $-4i - 4j - 32k$

(D) $-4i + 4j - 32k$

14. What is the volume of a parallelepiped with sides represented by the zero-based vectors **A**, **B**, and **C**?

$$A = 2i - 2j + k$$

$$B = 4i + 2j + 2k$$

$$C = i + 5j + 4k$$

(A) 14

(B) 28

(C) 35

(D) 42

15. What is the matrix product AB of matrices A and B ?

$$A = [1 \ 2 \ 3] \quad B = \begin{bmatrix} 2 \\ -3 \\ 4 \end{bmatrix}$$

(A) $\begin{bmatrix} 2 \\ -6 \\ 12 \end{bmatrix}$

(B) $[8]$

(C) $[20]$

(D) $[2 \ -6 \ 12]$

This problem refers to the following system of equations.

$$10x + 3y + 10z = 5$$

$$8x - 2y + 9z = 5$$

$$8x + y - 10z = 5$$

16. What is the cofactor matrix of the coefficient matrix?

(A) $\begin{bmatrix} 11 & 152 & 24 \\ 40 & -180 & 14 \\ 47 & -10 & -44 \end{bmatrix}$

(B) $\begin{bmatrix} 11 & -152 & 24 \\ -40 & 180 & 14 \\ 47 & 10 & 44 \end{bmatrix}$

(C) $\begin{bmatrix} 29 & -8 & -8 \\ -20 & -20 & 34 \\ 7 & 170 & 4 \end{bmatrix}$

(D) $\begin{bmatrix} 29 & 8 & -8 \\ 20 & -20 & -34 \\ 7 & -170 & 4 \end{bmatrix}$

17. What is the sum of the following finite sequence of terms?

18, 25, 32, 39, ..., 67

(A) 181

(B) 213

(C) 234

(D) 340

18. What is the sum of the following finite sequence of terms?

$32, 80, 200, \dots, 19531.25$

(A) 21,131.25

(B) 24,718.25

(C) 31,250

(D) 32,530.75

19. Which of the following statements is true for a power series with the general term $a_i x^i$?

- I. An infinite power series converges for $x < 1$.
- II. Power series can be added together or subtracted within their interval of convergence.
- III. Power series can be integrated within their interval of convergence.

(A) I only

(B) II only

(C) I and III

(D) II and III

20. Expand the function $f(x)$ about $a = 0$ to obtain $f(b)$. What are the first two terms of the Taylor series?

$$f(x) = \frac{1}{3x^3 + 4x + 8}$$

(A) $\frac{1}{16} + \frac{b}{8}$

(B) $\frac{1}{8} - \frac{b}{16}$

(C) $\frac{1}{8} + \frac{b}{16}$

(D) $\frac{1}{4} - \frac{b}{16}$

Probability and Statistics

21. Four fair coins are tossed at once. What is the probability of obtaining three heads and one tail?

(A) $\frac{1}{4}$

(B) $\frac{3}{8}$

(C) $\frac{1}{2}$

(D) $\frac{3}{4}$

22. What is the sample variance of the following numbers?

2, 4, 6, 8, 10, 12, 14

(A) 4.32

(B) 5.29

(C) 8.00

(D) 18.7

23. A bag contains 100 balls numbered 1 to 100. One ball is drawn from the bag. What is the probability that the number on the ball selected will be odd or greater than 80?

(A) 0.1

(B) 0.5

(C) 0.6

(D) 0.7

24. What is the maximum value of the following function?

$$y = 2x^3 + 12x^2 - 30x + 10$$

(A) -210

(B) -36

(C) -5

(D) 210

48
-28 -

Probability and Statistics

CALCULUS

DIFFERENTIAL CALCULUS

Derivatives

Critical Points

Partial Derivatives

Curvature

L'Hôpital's Rule

INTEGRAL CALCULUS

Fundamental Theorem of Calculus

Methods of Integration

CENTROIDS AND MOMENTS OF INERTIA

36. What is the Laplace transform of the step function $f(t)$?

$$f(t) = u(t - 1) + u(t - 2)$$

(A) $e^{-s} + e^{-2s}$

(B) $\frac{e^{-s} + e^{-2s}}{s}$

(C) $1 + \frac{e^{-2s}}{s}$

(D) $\frac{e^s}{s} + \frac{e^{2s}}{s}$

25. What is dy/dx if $y = (2x)^x$?

(A) $(3x)^x(2 + \ln 2x)$

(B) ~~$2x(1 + \ln 2x)$~~ $2x(1 + \ln 2x)$

(C) $(2x)^x(\ln 2x^2)$

(D) $(2x)^x(1 + \ln 2x)$

-31-

26. What is the partial derivative $\partial v / \partial y$ of the following function?

$$v = 3x^2 + 9xy - \frac{y}{\ln(x)} + \cos(z^2 + x)$$

(A) $9x - \frac{1}{\ln(x)}$

(B) $6x + 9x - \frac{1}{\ln(z)} - \sin(z^2 + x)$

(C) $3x^2y + \frac{9xy^2}{2} - \frac{y^2}{2\ln(z)} + \frac{\sin(z^2+x)}{z^2+x}$

(D) $9x + \frac{1}{\ln(z)}$

27. Evaluate the following limit.

$$\lim_{x \rightarrow \pi} \left(\frac{x^2 - \pi x + \sin x}{-\sin x} \right)$$

(A) 0

(B) 1

(C) $\pi - 1$

(D) $(2)(\pi - 1)$

28. Determine the following indefinite integral.

$$\int \frac{x^3 + x + 4}{x^2} dx$$

(A) $\frac{x}{4} + \ln|x| - \frac{4}{x} + C$

(B) $\frac{-x}{2} + \log(x) - 8x + C$

(C) $\frac{x^2}{2} + \ln|x| - \frac{2}{x^2} + c$

(D) $\frac{x^2}{2} + \ln|x| - \frac{4}{x} + C$

29. What is the volume of revolution from $x = 0$ to $x = 3/2$ when the function $f(x) = 3x - 2x^2$ is revolved around the y -axis?

(A) $3\pi/2$

(B) $27\pi/16$

(C) $13\pi/7$

(D) $35\pi/18$

Differential Equations and Transforms

Problems 30-31 refer to the following equation and initial conditions.

$$8y = e^{-2x} - 10y' - 2y''$$

$$y(0) = 1$$

$$y'(0) = -\frac{3}{2}$$

30. What type of differential equation is shown?

- (A) nonlinear, second-order, nonhomogeneous
- (B) linear, second-order, homogeneous
- (C) linear, second-order, nonhomogeneous
- (D) linear, third-order, nonhomogeneous

31. Which is a complete solution to the equation?

(A) $y = \frac{9}{4}e^x - \ln(2x)$

(B) $y = \frac{9}{4}e^x - 2e^{4x}$

(C) $y = \frac{41}{108}e^{-x} - \frac{11}{108}e^{-4x} + \frac{1}{36}e^{-2x}$

(D) $y = e^{-x} + \frac{1}{4}e^{-4x} - \frac{1}{4}e^{-3x}$

32. What is the correct general solution for the following differential equation?

$$\frac{d^2y}{dx^2} + 2\frac{dy}{dx} + 2y = 0$$

(A) $y = C_1 \sin x - C_2 \cos x$

(B) $y = C_1 \cos x - C_2 \sin x$

(C) $y = C_1 \cos x + C_2 \sin x$

(D) $y = e^{-x}(C_1 \cos x + C_2 \sin x)$

33. What is the Laplace transform of $\sin t \cos t$?

(A) $\frac{1}{s^2+4}$

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

(C) $\frac{1}{2t+2}$

(D) $\frac{1}{2s+4}$

Problems 34 and 35 refer to the transform function $\mathcal{L}(s)$.

$$\mathcal{L}(s) = \frac{20}{s(s+10)}$$

34. What is the partial function expansion of $\mathcal{L}(s)$?

(A) $\frac{1}{s} - \frac{1}{s+10}$

(B) $\frac{1}{s} - \frac{2}{s+10}$

(C) $\frac{2}{s} - \frac{1}{s+10}$

(D) $\frac{2}{s} - \frac{2}{s+10}$