King Fahd University of Petroleum and Minerals
Department of Mathematics

MATH 208
Major Exam II
Term 251
11 November 2025

EXAM COVER

Number of versions: 8
Number of questions: 15

King Fahd University of Petroleum and Minerals
Department of Mathematics
MATH 208
Major Exam II
Term 251
11 November 2025
Net Time Allowed: 90 Minutes

MASTER VERSION

1. If the rank of the matrix $\begin{bmatrix} 1 & 1 & 3 & 3 & 0 \\ -1 & 0 & -2 & -1 & 1 \\ 2 & 3 & 7 & 8 & \alpha \\ -2 & 4 & 0 & 6 & 7 \end{bmatrix}$ is equal to 3, then $\alpha =$

   (a) 1 ______________________________ (correct)
   (b) 0
   (c) 2
   (d) 3
   (e) -2

2. A basis for the subspace of $\mathbb{R}^3$ consists of the line of intersection of the planes $x - 4y + 7z = 0$ and $y = -z$ is given by $v = (\alpha, -1, 1)$ where $\alpha =$

   (a) -11 ______________________________ (correct)
   (b) 10
   (c) -10
   (d) 0
   (e) 9

3. If the solution space of the system

$$\begin{aligned} x_1 - 2x_2 - 3x_3 - 16x_4 = 0 \\ 2x_1 - 4x_2 + x_3 + 17x_4 = 0 \\ x_1 - 2x_2 + 3x_3 + 26x_4 = 0 \end{aligned}$$

Consists of all linear combination of the vectors
$v_1 = (a, 1, 0, b)$ and $v_2 = (c, 0, -7, d)$, then $a + b + c + d =$

(a) -2 ______ (correct)
(b) -3
(c) -4
(d) 5
(e) 0

4. If $W(x)$ is the Wronkian of the functions

$$f_1(x) = 2x + 3\cos x,\ f_2(x) = 5\cos x,\ f_3(x) = -3x,\ \text{then}\, W(x) =$$

(a) 0 ______ (correct)
(b) $2x$
(c) $-2x$
(d) $\sin x$
(e) $3\ \cos x$

5. If $y(x)$ is the solution of the initial-value problem

$$(D+2)^2\, y = 0,\ y(0) = 1,\ y'(0) = -1, \text{ then } y\left(\frac{1}{2}\right) =$$

(a) $\dfrac{3}{2e}$ ———————— (correct)
(b) $\dfrac{3}{e}$
(c) $\dfrac{5}{e}$
(d) $\dfrac{5}{2e}$
(e) 0

6. The general solution of the differential equation

$$(D^5 - 2D^3 - 2D^2 - 3D - 2)\, y = 0 \text{ is}$$

(a) $y(x) = e^{-x}(c_1 + c_2 x) + c_3\, e^{2x} + c_4\, \cos x + c_5 \sin x$ ———————— (correct)
(b) $y(x) = c_1 e^{-x} + (c_2 + c_3 x)\, e^{2x} + c_4\, \cos x + c_5\, \sin x$
(c) $y(x) = e^{x}(c_1 + c_2 x) + c_3\, e^{2x} + c_4\, \cos x + c_5\, \sin x$
(d) $y(x) = e^{-x}(c_1 + c_2 x) + c_3 e^{2x} + c_4\, e^{x} \cos x + c_5\, e^{x} \sin x$
(e) $y(x) = e^{-x}(c_1 + c_2 x) + c_3\, e^{2x} + c_4\, e^{-x} \cos x + c_5\, e^{-x} \sin x$

7. A linear homogeneous differential equation with real coefficients having the solutions xe^x, $5e^x\cos(3x)$ is

   (a) $y^{(4)} - 4y^{(3)} + 15y'' - 22y' + 10y = 0$ ______ (correct)
   (b) $y^{(4)} + 4y^{(3)} + 15y'' - 22y' + 2y = 0$
   (c) $y^{(4)} - 4y^{(3)} + 13y'' - 22y' + 12y = 0$
   (d) $y^{(4)} - 4y^{(3)} + 15y'' - 20y' + 8y = 0$
   (e) $y^{(4)} - 10y^{(3)} + 15y'' - 22y' + 16y = 0$

8. If $y_p = Ax^3 + Bx^2 + Cx + D\ \cos x + E\ \sin x$ is a particular solution of the differential equation

   $$y''' + 4y' = 24(x^2 + \sin x),\ \text{then } A + B + C + D + E =$$

   (a) -9 ______ (correct)
   (b) 9
   (c) -8
   (d) 8
   (e) 11

9. An appropriate form of a particular solution y_p for the non-homogeneous differential equation

$$(D^2 - 1)^2\, y = e^x + \sin x$$

is given by $y_p(x) =$

(a) $Ax^2e^x + B\cos x + C\sin x$ ________ (correct)

(b) $Ae^x + B\cos x + C\sin x$

(c) $Axe^x + B\cos x + C\sin x$

(d) $Ax^2e^x + B\sin x$

(e) $Ax^2e^x + Bx^2\cos x + Cx^2\sin x$

10. Given that $y = e^{-x}\cos x$ is a solution of the differential equation $9y^{(3)} + 11y'' + 4y' - 14y = 0$. The general solution of the differential equation is

(a) $y = c_1\, e^{\frac{7}{9}x} + c_2\, e^{-x}\cos x + c_3\, e^{-x}\sin x$ ________ (correct)

(b) $y = c_1\, e^{\frac{2}{9}x} + c_2\, e^{-x}\cos x + c_3\, e^{-x}\sin x$

(c) $y = c_1\, e^{-\frac{7}{9}x} + c_2\, e^{-x}\cos x + c_3\, e^{-x}\sin x$

(d) $y = c_1\, e^{-\frac{2}{9}x} + c_2\, e^{-x}\cos x + c_3\, e^{-x}\sin x$

(e) $y = c_1\, e^{x} + c_2\, e^{-x}\cos x + c_3\, e^{-x}\sin x$

11. A particular solution of the differential equation

$$y'' - 3y' + 2y = \cos(e^{-x})$$

is given by $y_p(x) =$

(a) $-e^{2x}\ \cos\left(e^{-x}\right)$ ________________ (correct)
(b) $e^{x}\ \cos\left(e^{-x}\right) + e^{2x}\sin(e^{-x})$
(c) $2e^{2x}\ \sin\left(e^{-x}\right)$
(d) $2e^{x}\ \cos\left(e^{-x}\right) + e^{2x}\sin(e^{-x})$
(e) $-2e^{2x}\ \cos\left(e^{-x}\right)$

12. The characteristic equation of the matrix $\begin{bmatrix} 0 & 1 & -1 \\ -3 & 1 & -3 \\ 1 & -4 & 2 \end{bmatrix}$ is

(a) $\lambda^3 - 3\lambda^2 - 6\lambda + 8 = 0$ ________________ (correct)
(b) $\lambda^3 - 4\lambda^2 - 6\lambda + 8 = 0$
(c) $\lambda^3 - 3\lambda^2 + 6\lambda - 8 = 0$
(d) $\lambda^3 - 5\lambda^2 - 6\lambda - 8 = 0$
(e) $\lambda^3 - 3\lambda^2 - 5\lambda + 6 = 0$

13. An eigenvector associated with the eigenvalue $\lambda = 5$ of the matrix $A = \begin{bmatrix} 5 & 0 \\ 4 & -1 \end{bmatrix}$ is $\begin{bmatrix} 3 \\ \alpha \end{bmatrix}$ where $\alpha =$

(a) 2 ________________ (correct)

(b) -2

(c) 3

(d) -3

(e) 1

14. If the characteristic polynomial of the matrix

$$A = \begin{bmatrix} 0 & 3 & 1 \\ 1 & 2 & 1 \\ 1 & 3 & 0 \end{bmatrix} \text{ is } p(\lambda) = -(\lambda + 1)^2(\lambda - 4),$$

then a basis for the eigenspace of $\lambda = -1$ is $v_1 = \begin{bmatrix} \alpha \\ 0 \\ -1 \end{bmatrix}$, $v_2 = \begin{bmatrix} \beta \\ -1 \\ 0 \end{bmatrix}$, where $\alpha + \beta =$

(a) 4 ________________ (correct)

(b) -4

(c) 0

(d) 3

(e) 2

15. If the matrix $A = \begin{bmatrix} -1 & 3 \\ -2 & 4 \end{bmatrix}$ is diagonalizable with a diagonalizing matrix P and a diagonal matrix D such that $P^{-1}AP = D$, then

(a) $P = [31211002$ ____ (correct)

(b) $P = [13121002$

(c) $P = [31 - 211002$

(d) $P = [13121002$

(e) $P = [131 - 20120$

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CODE 1 **CODE 1**

MATH 208
Major Exam II
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Name	

ID		**Sec**	

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3. Use a good eraser. DO NOT use the erasers attached to the pencil.
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1. The general solution of the differential equation

$$(D^5 - 2D^3 - 2D^2 - 3D - 2)\, y = 0 \text{ is}$$

(a) $y(x) = c_1 e^{-x} + (c_2 + c_3 x)\, e^{2x} + c_4 \cos x + c_5 \sin x$
(b) $y(x) = e^{-x}(c_1 + c_2 x) + c_3\, e^{2x} + c_4 \cos x + c_5 \sin x$
(c) $y(x) = e^{x}(c_1 + c_2 x) + c_3\, e^{2x} + c_4 \cos x + c_5 \sin x$
(d) $y(x) = e^{-x}(c_1 + c_2 x) + c_3\, e^{2x} + c_4\, e^{-x} \cos x + c_5\, e^{-x} \sin x$
(e) $y(x) = e^{-x}(c_1 + c_2 x) + c_3 e^{2x} + c_4\, e^{x} \cos x + c_5\, e^{x} \sin x$

2. A linear homogeneous differential equation with real coefficients having the solutions xe^x, $5e^x \cos(3x)$ is

(a) $y^{(4)} - 4y^{(3)} + 15y'' - 22y' + 10y = 0$
(b) $y^{(4)} - 10y^{(3)} + 15y'' - 22y' + 16y = 0$
(c) $y^{(4)} - 4y^{(3)} + 13y'' - 22y' + 12y = 0$
(d) $y^{(4)} - 4y^{(3)} + 15y'' - 20y' + 8y = 0$
(e) $y^{(4)} + 4y^{(3)} + 15y'' - 22y' + 2y = 0$

3. If the matrix $A = \begin{bmatrix} -1 & 3 \\ -2 & 4 \end{bmatrix}$ is diagonalizable with a diagonalizing matrix P and a diagonal matrix D such that $P^{-1}AP = D$, then

(a) $P = [31 - 211002$

(b) $P = [131 - 20120$

(c) $P = [13121002$

(d) $P = [13121002$

(e) $P = [31211002$

4. If the rank of the matrix $\begin{bmatrix} 1 & 1 & 3 & 3 & 0 \\ -1 & 0 & -2 & -1 & 1 \\ 2 & 3 & 7 & 8 & \alpha \\ -2 & 4 & 0 & 6 & 7 \end{bmatrix}$ is equal to 3, then $\alpha =$

(a) -2

(b) 0

(c) 2

(d) 1

(e) 3

5. If the solution space of the system

$$\begin{aligned} x_1 - 2x_2 - 3x_3 - 16x_4 = 0 \\ 2x_1 - 4x_2 + x_3 + 17x_4 = 0 \\ x_1 - 2x_2 + 3x_3 + 26x_4 = 0 \end{aligned}$$

Consists of all linear combination of the vectors
$v_1 = (a, 1, 0, b)$ and $v_2 = (c, 0, -7, d)$, then $a + b + c + d =$

(a) -3
(b) -2
(c) 5
(d) -4
(e) 0

6. If $W(x)$ is the Wronkian of the functions

$$f_1(x) = 2x + 3\cos x,\ f_2(x) = 5\cos x,\ f_3(x) = -3x, \text{ then } W(x) =$$

(a) $-2x$
(b) $2x$
(c) 0
(d) $\sin x$
(e) $3\ \cos x$

7. An eigenvector associated with the eigenvalue $\lambda = 5$ of the matrix $A = \begin{bmatrix} 5 & 0 \\ 4 & -1 \end{bmatrix}$ is $\begin{bmatrix} 3 \\ \alpha \end{bmatrix}$ where $\alpha =$

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

8. The characteristic equation of the matrix $\begin{bmatrix} 0 & 1 & -1 \\ -3 & 1 & -3 \\ 1 & -4 & 2 \end{bmatrix}$ is

(a) $\lambda^3 - 4\lambda^2 - 6\lambda + 8 = 0$
(b) $\lambda^3 - 3\lambda^2 + 6\lambda - 8 = 0$
(c) $\lambda^3 - 5\lambda^2 - 6\lambda - 8 = 0$
(d) $\lambda^3 - 3\lambda^2 - 6\lambda + 8 = 0$
(e) $\lambda^3 - 3\lambda^2 - 5\lambda + 6 = 0$

9. If $y_p = Ax^3 + Bx^2 + Cx + D\ \cos x + E\ \sin x$ is a particular solution of the differential equation

$$y''' + 4y' = 24(x^2 + \sin x), \text{ then } A + B + C + D + E =$$

(a) 8

(b) 9

(c) 11

(d) -9

(e) -8

10. A particular solution of the differential equation

$$y'' - 3y' + 2y = \cos(e^{-x})$$

is given by $y_p(x) =$

(a) $e^x\ \cos(e^{-x}) + e^{2x}\sin(e^{-x})$

(b) $-2e^{2x}\ \cos(e^{-x})$

(c) $-e^{2x}\ \cos(e^{-x})$

(d) $2e^{2x}\ \sin(e^{-x})$

(e) $2e^x\ \cos(e^{-x}) + e^{2x}\sin(e^{-x})$

11. If $y(x)$ is the solution of the initial-value problem

$$(D+2)^2\, y = 0,\ y(0) = 1,\ y'(0) = -1, \text{ then } y\left(\frac{1}{2}\right) =$$

(a) $\frac{5}{e}$

(b) $\frac{3}{2e}$

(c) $\frac{5}{2e}$

(d) 0

(e) $\frac{3}{e}$

12. If the characteristic polynomial of the matrix

$$A = \begin{bmatrix} 0 & 3 & 1 \\ 1 & 2 & 1 \\ 1 & 3 & 0 \end{bmatrix} \text{ is } p(\lambda) = -(\lambda+1)^2(\lambda-4),$$

then a basis for the eigenspace of $\lambda = -1$ is $v_1 = \begin{bmatrix} \alpha \\ 0 \\ -1 \end{bmatrix}$, $v_2 = \begin{bmatrix} \beta \\ -1 \\ 0 \end{bmatrix}$, where $\alpha + \beta =$

(a) 0

(b) 2

(c) 4

(d) -4

(e) 3

13. A basis for the subspace of $\mathbb{R}^3$ consists of the line of intersection of the planes $x - 4y + 7z = 0$ and $y = -z$ is given by $v = (\alpha, -1, 1)$ where $\alpha =$

(a) -11
(b) -10
(c) 0
(d) 9
(e) 10

14. Given that $y = e^{-x}\cos x$ is a solution of the differential equation $9y^{(3)} + 11y'' + 4y' - 14y = 0$. The general solution of the differential equation is

(a) $y = c_1\, e^{-\frac{2}{9}x} + c_2\, e^{-x}\cos x + c_3\, e^{-x}\sin x$
(b) $y = c_1\, e^{\frac{2}{9}x} + c_2\, e^{-x}\cos x + c_3\, e^{-x}\sin x$
(c) $y = c_1\, e^{-\frac{7}{9}x} + c_2\, e^{-x}\cos x + c_3\, e^{-x}\sin x$
(d) $y = c_1\, e^{x} + c_2\, e^{-x}\cos x + c_3\, e^{-x}\sin x$
(e) $y = c_1\, e^{\frac{7}{9}x} + c_2\, e^{-x}\cos x + c_3\, e^{-x}\sin x$

15. An appropriate form of a particular solution y_p for the non-homogeneous differential equation

$$(D^2 - 1)^2\, y = e^x + \sin x$$

is given by $y_p(x) =$

(a) $Ae^x + B\cos x + C\sin x$

(b) $Ax^2e^x + B\sin x$

(c) $Ax^2e^x + B\cos x + C\sin x$

(d) $Ax^2e^x + Bx^2\cos x + Cx^2\sin x$

(e) $Axe^x + B\cos x + C\sin x$

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CODE 2 **CODE 2**

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11 November 2025
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Name	
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1. If the rank of the matrix $\begin{bmatrix} 1 & 1 & 3 & 3 & 0 \\ -1 & 0 & -2 & -1 & 1 \\ 2 & 3 & 7 & 8 & \alpha \\ -2 & 4 & 0 & 6 & 7 \end{bmatrix}$ is equal to 3, then $\alpha =$

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

2. The characteristic equation of the matrix $\begin{bmatrix} 0 & 1 & -1 \\ -3 & 1 & -3 \\ 1 & -4 & 2 \end{bmatrix}$ is

(a) $\lambda^3 - 4\lambda^2 - 6\lambda + 8 = 0$
(b) $\lambda^3 - 3\lambda^2 - 5\lambda + 6 = 0$
(c) $\lambda^3 - 3\lambda^2 + 6\lambda - 8 = 0$
(d) $\lambda^3 - 5\lambda^2 - 6\lambda - 8 = 0$
(e) $\lambda^3 - 3\lambda^2 - 6\lambda + 8 = 0$

3. An eigenvector associated with the eigenvalue $\lambda = 5$ of the matrix $A = \begin{bmatrix} 5 & 0 \\ 4 & -1 \end{bmatrix}$ is $\begin{bmatrix} 3 \\ \alpha \end{bmatrix}$ where $\alpha =$

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

4. A basis for the subspace of $\mathbb{R}^3$ consists of the line of intersection of the planes $x - 4y + 7z = 0$ and $y = -z$ is given by $v = (\alpha, -1, 1)$ where $\alpha =$

   (a) 0
   (b) -10
   (c) 9
   (d) 10
   (e) -11

5. A linear homogeneous differential equation with real coefficients having the solutions xe^x, $5e^x\cos(3x)$ is

(a) $y^{(4)} - 4y^{(3)} + 15y'' - 22y' + 10y = 0$

(b) $y^{(4)} - 4y^{(3)} + 15y'' - 20y' + 8y = 0$

(c) $y^{(4)} - 4y^{(3)} + 13y'' - 22y' + 12y = 0$

(d) $y^{(4)} - 10y^{(3)} + 15y'' - 22y' + 16y = 0$

(e) $y^{(4)} + 4y^{(3)} + 15y'' - 22y' + 2y = 0$

6. If the solution space of the system

$$\begin{aligned}
&x_1 - 2x_2 - 3x_3 - 16x_4 = 0\\
&2x_1 - 4x_2 + x_3 + 17x_4 = 0\\
&x_1 - 2x_2 + 3x_3 + 26x_4 = 0
\end{aligned}$$

Consists of all linear combination of the vectors
$v_1 = (a, 1, 0, b)$ and $v_2 = (c, 0, -7, d)$, then $a + b + c + d =$

(a) 5

(b) 0

(c) -3

(d) -2

(e) -4

7. Given that $y = e^{-x}\cos x$ is a solution of the differential equation $9y^{(3)} + 11y'' + 4y' - 14y = 0$. The general solution of the differential equation is

(a) $y = c_1\, e^{x} + c_2\, e^{-x}\cos x + c_3\, e^{-x}\sin x$

(b) $y = c_1\, e^{-\frac{2}{9}x} + c_2\, e^{-x}\cos x + c_3\, e^{-x}\sin x$

(c) $y = c_1\, e^{\frac{7}{9}x} + c_2\, e^{-x}\cos x + c_3\, e^{-x}\sin x$

(d) $y = c_1\, e^{-\frac{7}{9}x} + c_2\, e^{-x}\cos x + c_3\, e^{-x}\sin x$

(e) $y = c_1\, e^{\frac{2}{9}x} + c_2\, e^{-x}\cos x + c_3\, e^{-x}\sin x$

8. If $y(x)$ is the solution of the initial-value problem

$$(D+2)^2\, y = 0,\ y(0) = 1,\ y'(0) = -1, \text{ then } y\left(\frac{1}{2}\right) =$$

(a) $\dfrac{5}{2e}$

(b) $\dfrac{3}{2e}$

(c) 0

(d) $\dfrac{5}{e}$

(e) $\dfrac{3}{e}$

9. If $W(x)$ is the Wronkian of the functions

$$f_1(x) = 2x + 3\cos x,\ f_2(x) = 5\cos x,\ f_3(x) = -3x, \text{ then } W(x) =$$

(a) $-2x$

(b) $3\ \cos x$

(c) $\sin x$

(d) $2x$

(e) 0

10. A particular solution of the differential equation

$$y'' - 3y' + 2y = \cos(e^{-x})$$

is given by $y_p(x) =$

(a) $e^x\ \cos(e^{-x}) + e^{2x}\sin(e^{-x})$

(b) $2e^x\ \cos(e^{-x}) + e^{2x}\sin(e^{-x})$

(c) $-e^{2x}\ \cos(e^{-x})$

(d) $-2e^{2x}\ \cos(e^{-x})$

(e) $2e^{2x}\ \sin(e^{-x})$

11. If $y_p = Ax^3 + Bx^2 + Cx + D\,\cos x + E\,\sin x$ is a particular solution of the differential equation

$$y''' + 4y' = 24(x^2 + \sin x), \text{ then } A + B + C + D + E =$$

(a) -9

(b) 11

(c) 9

(d) 8

(e) -8

12. If the characteristic polynomial of the matrix

$$A = \begin{bmatrix} 0 & 3 & 1 \\ 1 & 2 & 1 \\ 1 & 3 & 0 \end{bmatrix} \text{ is } p(\lambda) = -(\lambda+1)^2(\lambda-4),$$

then a basis for the eigenspace of $\lambda = -1$ is $v_1 = \begin{bmatrix} \alpha \\ 0 \\ -1 \end{bmatrix}$, $v_2 = \begin{bmatrix} \beta \\ -1 \\ 0 \end{bmatrix}$, where

$\alpha + \beta =$

(a) 3

(b) 4

(c) -4

(d) 2

(e) 0

13. The general solution of the differential equation

$$(D^5 - 2D^3 - 2D^2 - 3D - 2)\, y = 0 \text{ is}$$

(a) $y(x) = e^{x}(c_1 + c_2 x) + c_3\, e^{2x} + c_4\, \cos x + c_5\, \sin x$

(b) $y(x) = e^{-x}(c_1 + c_2 x) + c_3\, e^{2x} + c_4\, e^{-x} \cos x + c_5\, e^{-x} \sin x$

(c) $y(x) = e^{-x}(c_1 + c_2 x) + c_3 e^{2x} + c_4\, e^{x} \cos x + c_5\, e^{x} \sin x$

(d) $y(x) = e^{-x}(c_1 + c_2 x) + c_3\, e^{2x} + c_4\, \cos x + c_5 \sin x$

(e) $y(x) = c_1 e^{-x} + (c_2 + c_3 x)\, e^{2x} + c_4\, \cos x + c_5\, \sin x$

14. If the matrix $A = \begin{bmatrix} -1 & 3 \\ -2 & 4 \end{bmatrix}$ is diagonalizable with a diagonalizing matrix P and a diagonal matrix D such that $P^{-1}AP = D$, then

(a) $P = [131 - 20120$

(b) $P = [31211002$

(c) $P = [31 - 211002$

(d) $P = [13121002$

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15. An appropriate form of a particular solution y_p for the non-homogeneous differential equation

$$(D^2 - 1)^2\, y = e^x + \sin x$$

is given by $y_p(x) =$

(a) $Ax^2e^x + Bx^2\cos x + Cx^2\sin x$

(b) $Ae^x + B\cos x + C\sin x$

(c) $Axe^x + B\cos x + C\sin x$

(d) $Ax^2e^x + B\cos x + C\sin x$

(e) $Ax^2e^x + B\sin x$

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8. When erasing a bubble, make sure that you do not leave any trace of penciling.

1. The characteristic equation of the matrix $\begin{bmatrix} 0 & 1 & -1 \\ -3 & 1 & -3 \\ 1 & -4 & 2 \end{bmatrix}$ is

(a) $\lambda^3 - 3\lambda^2 + 6\lambda - 8 = 0$
(b) $\lambda^3 - 5\lambda^2 - 6\lambda - 8 = 0$
(c) $\lambda^3 - 3\lambda^2 - 5\lambda + 6 = 0$
(d) $\lambda^3 - 3\lambda^2 - 6\lambda + 8 = 0$
(e) $\lambda^3 - 4\lambda^2 - 6\lambda + 8 = 0$

2. A linear homogeneous differential equation with real coefficients having the solutions xe^x, $5e^x\cos(3x)$ is

(a) $y^{(4)} - 4y^{(3)} + 13y'' - 22y' + 12y = 0$
(b) $y^{(4)} + 4y^{(3)} + 15y'' - 22y' + 2y = 0$
(c) $y^{(4)} - 10y^{(3)} + 15y'' - 22y' + 16y = 0$
(d) $y^{(4)} - 4y^{(3)} + 15y'' - 22y' + 10y = 0$
(e) $y^{(4)} - 4y^{(3)} + 15y'' - 20y' + 8y = 0$

3. If $y(x)$ is the solution of the initial-value problem

$$(D+2)^2\, y = 0,\ y(0) = 1,\ y'(0) = -1, \text{ then}\, y\left(\frac{1}{2}\right) =$$

(a) $\frac{3}{e}$
(b) $\frac{5}{2e}$
(c) $\frac{3}{2e}$
(d) $\frac{5}{e}$
(e) 0

4. If $W(x)$ is the Wronkian of the functions

$$f_1(x) = 2x + 3\cos x,\ f_2(x) = 5\cos x,\ f_3(x) = -3x, \text{ then}\, W(x) =$$

(a) $\sin x$
(b) $2x$
(c) 0
(d) $3\,\cos x$
(e) $-2x$

5. If the characteristic polynomial of the matrix

$$A = \begin{bmatrix} 0 & 3 & 1 \\ 1 & 2 & 1 \\ 1 & 3 & 0 \end{bmatrix} \text{ is } p(\lambda) = -(\lambda+1)^2(\lambda-4),$$

then a basis for the eigenspace of $\lambda = -1$ is $v_1 = \begin{bmatrix} \alpha \\ 0 \\ -1 \end{bmatrix}$, $v_2 = \begin{bmatrix} \beta \\ -1 \\ 0 \end{bmatrix}$, where $\alpha + \beta =$

(a) 2
(b) 4
(c) 0
(d) -4
(e) 3

6. If the solution space of the system

$$\begin{aligned} x_1 - 2x_2 - 3x_3 - 16x_4 &= 0 \\ 2x_1 - 4x_2 + x_3 + 17x_4 &= 0 \\ x_1 - 2x_2 + 3x_3 + 26x_4 &= 0 \end{aligned}$$

Consists of all linear combination of the vectors
$v_1 = (a, 1, 0, b)$ and $v_2 = (c, 0, -7, d)$, then $a + b + c + d =$

(a) -4
(b) 5
(c) -3
(d) 0
(e) -2

7. A basis for the subspace of $\mathbb{R}^3$ consists of the line of intersection of the planes $x - 4y + 7z = 0$ and $y = -z$ is given by $v = (\alpha, -1, 1)$ where $\alpha =$

(a) -11
(b) 0
(c) 10
(d) 9
(e) -10

8. The general solution of the differential equation

$$(D^5 - 2D^3 - 2D^2 - 3D - 2)\, y = 0 \text{ is}$$

(a) $y(x) = c_1 e^{-x} + (c_2 + c_3 x)\, e^{2x} + c_4 \cos x + c_5 \sin x$
(b) $y(x) = e^{-x}(c_1 + c_2 x) + c_3\, e^{2x} + c_4\, e^{-x} \cos x + c_5\, e^{-x} \sin x$
(c) $y(x) = e^{x}(c_1 + c_2 x) + c_3\, e^{2x} + c_4 \cos x + c_5 \sin x$
(d) $y(x) = e^{-x}(c_1 + c_2 x) + c_3\, e^{2x} + c_4 \cos x + c_5 \sin x$
(e) $y(x) = e^{-x}(c_1 + c_2 x) + c_3 e^{2x} + c_4\, e^{x} \cos x + c_5\, e^{x} \sin x$

9. A particular solution of the differential equation

$$y'' - 3y' + 2y = \cos(e^{-x})$$

is given by $y_p(x) =$

(a) $2e^{x}\cos(e^{-x}) + e^{2x}\sin(e^{-x})$
(b) $e^{x}\cos(e^{-x}) + e^{2x}\sin(e^{-x})$
(c) $-e^{2x}\cos(e^{-x})$
(d) $2e^{2x}\sin(e^{-x})$
(e) $-2e^{2x}\cos(e^{-x})$

10. An eigenvector associated with the eigenvalue $\lambda = 5$ of the matrix $A = \begin{bmatrix} 5 & 0 \\ 4 & -1 \end{bmatrix}$ is $\begin{bmatrix} 3 \\ \alpha \end{bmatrix}$ where $\alpha =$

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

11. If the rank of the matrix $\begin{bmatrix} 1 & 1 & 3 & 3 & 0 \\ -1 & 0 & -2 & -1 & 1 \\ 2 & 3 & 7 & 8 & \alpha \\ -2 & 4 & 0 & 6 & 7 \end{bmatrix}$ is equal to 3, then $\alpha =$

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

12. If the matrix $A = \begin{bmatrix} -1 & 3 \\ -2 & 4 \end{bmatrix}$ is diagonalizable with a diagonalizing matrix P and a diagonal matrix D such that $P^{-1}AP = D$, then

(a) $P =$ [13121002
(b) $P =$ [13121002
(c) $P =$ [31 – 211002
(d) $P =$ [131 – 20120
(e) $P =$ [31211002

13. Given that $y = e^{-x}\cos x$ is a solution of the differential equation $9y^{(3)} + 11y'' + 4y' - 14y = 0$. The general solution of the differential equation is

(a) $y = c_1\, e^{x} + c_2\, e^{-x}\cos x + c_3\, e^{-x}\sin x$
(b) $y = c_1\, e^{\frac{7}{9}x} + c_2\, e^{-x}\cos x + c_3\, e^{-x}\sin x$
(c) $y = c_1\, e^{-\frac{7}{9}x} + c_2\, e^{-x}\cos x + c_3\, e^{-x}\sin x$
(d) $y = c_1\, e^{-\frac{2}{9}x} + c_2\, e^{-x}\cos x + c_3\, e^{-x}\sin x$
(e) $y = c_1\, e^{\frac{2}{9}x} + c_2\, e^{-x}\cos x + c_3\, e^{-x}\sin x$

14. If $y_p = Ax^3 + Bx^2 + Cx + D\ \cos x + E\ \sin x$ is a particular solution of the differential equation

$$y''' + 4y' = 24(x^2 + \sin x),\ \text{ then } A + B + C + D + E =$$

(a) 9
(b) 8
(c) -9
(d) 11
(e) -8

15. An appropriate form of a particular solution y_p for the non-homogeneous differential equation

$$(D^2-1)^2\,y = e^x + \sin x$$

is given by $y_p(x) =$

(a) $Ax^2e^x + Bx^2\cos x + Cx^2\sin x$

(b) $Ax^2e^x + B\sin x$

(c) $Ae^x + B\cos x + C\sin x$

(d) $Axe^x + B\cos x + C\sin x$

(e) $Ax^2e^x + B\cos x + C\sin x$

King Fahd University of Petroleum and Minerals
Department of Mathematics

CODE 4 **CODE 4**

MATH 208
Major Exam II
Term 251
11 November 2025
Net Time Allowed: 90 Minutes

Name	
ID		**Sec**	

Check that this exam has 15 questions.

Important Instructions:

1. All types of calculators, smart watches or mobile phones are NOT allowed during the examination.
2. Use HB 2.5 pencils only.
3. Use a good eraser. DO NOT use the erasers attached to the pencil.
4. Write your name, ID number and Section number on the examination paper and in the upper left corner of the answer sheet.
5. When bubbling your ID number and Section number, be sure that the bubbles match with the numbers that you write.
6. The Test Code Number is already bubbled in your answer sheet. Make sure that it is the same as that printed on your question paper.
7. When bubbling, make sure that the bubbled space is fully covered.
8. When erasing a bubble, make sure that you do not leave any trace of penciling.

1. If $W(x)$ is the Wronkian of the functions

$$f_1(x) = 2x + 3\cos x,\ f_2(x) = 5\cos x,\ f_3(x) = -3x, \text{ then } W(x) =$$

(a) $3\ \cos x$
(b) $\sin x$
(c) $2x$
(d) $-2x$
(e) 0

2. The characteristic equation of the matrix $\begin{bmatrix} 0 & 1 & -1 \\ -3 & 1 & -3 \\ 1 & -4 & 2 \end{bmatrix}$ is

(a) $\lambda^3 - 3\lambda^2 - 5\lambda + 6 = 0$
(b) $\lambda^3 - 5\lambda^2 - 6\lambda - 8 = 0$
(c) $\lambda^3 - 4\lambda^2 - 6\lambda + 8 = 0$
(d) $\lambda^3 - 3\lambda^2 - 6\lambda + 8 = 0$
(e) $\lambda^3 - 3\lambda^2 + 6\lambda - 8 = 0$

3. Given that $y = e^{-x}\cos x$ is a solution of the differential equation $9y^{(3)} + 11y'' + 4y' - 14y = 0$. The general solution of the differential equation is

(a) $y = c_1\, e^{-\frac{2}{9}x} + c_2\, e^{-x}\cos x + c_3\, e^{-x}\sin x$

(b) $y = c_1\, e^{\frac{2}{9}x} + c_2\, e^{-x}\cos x + c_3\, e^{-x}\sin x$

(c) $y = c_1\, e^{x} + c_2\, e^{-x}\cos x + c_3\, e^{-x}\sin x$

(d) $y = c_1\, e^{-\frac{7}{9}x} + c_2\, e^{-x}\cos x + c_3\, e^{-x}\sin x$

(e) $y = c_1\, e^{\frac{7}{9}x} + c_2\, e^{-x}\cos x + c_3\, e^{-x}\sin x$

4. If $y_p = Ax^3 + Bx^2 + Cx + D\ \cos x + E\ \sin x$ is a particular solution of the differential equation

$$y''' + 4y' = 24(x^2 + \sin x),\ \text{ then } A + B + C + D + E =$$

(a) 8

(b) -9

(c) 9

(d) -8

(e) 11

5. An eigenvector associated with the eigenvalue $\lambda = 5$ of the matrix $A = \begin{bmatrix} 5 & 0 \\ 4 & -1 \end{bmatrix}$ is $\begin{bmatrix} 3 \\ \alpha \end{bmatrix}$ where $\alpha =$

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

6. A basis for the subspace of $\mathbb{R}^3$ consists of the line of intersection of the planes $x - 4y + 7z = 0$ and $y = -z$ is given by $v = (\alpha, -1, 1)$ where $\alpha =$

(a) -10
(b) 9
(c) 10
(d) -11
(e) 0

7. A particular solution of the differential equation

$$y'' - 3y' + 2y = \cos(e^{-x})$$

is given by $y_p(x) =$

(a) $-e^{2x}\,\cos\left(e^{-x}\right)$
(b) $2e^{x}\,\cos\left(e^{-x}\right) + e^{2x}\sin(e^{-x})$
(c) $-2e^{2x}\,\cos\left(e^{-x}\right)$
(d) $e^{x}\,\cos\left(e^{-x}\right) + e^{2x}\sin(e^{-x})$
(e) $2e^{2x}\,\sin\left(e^{-x}\right)$

8. A linear homogeneous differential equation with real coefficients having the solutions xe^x, $5e^x\cos(3x)$ is

(a) $y^{(4)} - 4y^{(3)} + 15y'' - 20y' + 8y = 0$
(b) $y^{(4)} - 4y^{(3)} + 13y'' - 22y' + 12y = 0$
(c) $y^{(4)} - 10y^{(3)} + 15y'' - 22y' + 16y = 0$
(d) $y^{(4)} + 4y^{(3)} + 15y'' - 22y' + 2y = 0$
(e) $y^{(4)} - 4y^{(3)} + 15y'' - 22y' + 10y = 0$

9. If the characteristic polynomial of the matrix

$$A = \begin{bmatrix} 0 & 3 & 1 \\ 1 & 2 & 1 \\ 1 & 3 & 0 \end{bmatrix} \text{ is } p(\lambda) = -(\lambda+1)^2(\lambda-4),$$

then a basis for the eigenspace of $\lambda = -1$ is $v_1 = \begin{bmatrix} \alpha \\ 0 \\ -1 \end{bmatrix}$, $v_2 = \begin{bmatrix} \beta \\ -1 \\ 0 \end{bmatrix}$, where

$\alpha + \beta =$

(a) -4
(b) 4
(c) 2
(d) 3
(e) 0

10. If the solution space of the system

$$\begin{aligned} x_1 - 2x_2 - 3x_3 - 16x_4 &= 0 \\ 2x_1 - 4x_2 + x_3 + 17x_4 &= 0 \\ x_1 - 2x_2 + 3x_3 + 26x_4 &= 0 \end{aligned}$$

Consists of all linear combination of the vectors
$v_1 = (a, 1, 0, b)$ and $v_2 = (c, 0, -7, d)$, then $a + b + c + d =$

(a) -4
(b) -3
(c) 0
(d) 5
(e) -2

11. If $y(x)$ is the solution of the initial-value problem

$$(D+2)^2\, y = 0,\ y(0) = 1,\ y'(0) = -1, \text{ then}\, y\left(\frac{1}{2}\right) =$$

(a) $\frac{5}{2e}$
(b) $\frac{5}{e}$
(c) $\frac{3}{e}$
(d) $\frac{3}{2e}$
(e) 0

12. If the matrix $A = \begin{bmatrix} -1 & 3 \\ -2 & 4 \end{bmatrix}$ is diagonalizable with a diagonalizing matrix P and a diagonal matrix D such that $P^{-1}AP = D$, then

(a) $P =$ [13121002
(b) $P =$ [31 – 211002
(c) $P =$ [31211002
(d) $P =$ [13121002
(e) $P =$ [131 – 20120

13. If the rank of the matrix $\begin{bmatrix} 1 & 1 & 3 & 3 & 0 \\ -1 & 0 & -2 & -1 & 1 \\ 2 & 3 & 7 & 8 & \alpha \\ -2 & 4 & 0 & 6 & 7 \end{bmatrix}$ is equal to 3, then $\alpha =$

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

14. The general solution of the differential equation

$$(D^5 - 2D^3 - 2D^2 - 3D - 2)\, y = 0 \text{ is}$$

(a) $y(x) = e^{-x}(c_1 + c_2 x) + c_3\, e^{2x} + c_4 \cos x + c_5 \sin x$
(b) $y(x) = e^{x}(c_1 + c_2 x) + c_3\, e^{2x} + c_4 \cos x + c_5 \sin x$
(c) $y(x) = e^{-x}(c_1 + c_2 x) + c_3 e^{2x} + c_4\, e^{x} \cos x + c_5\, e^{x} \sin x$
(d) $y(x) = c_1 e^{-x} + (c_2 + c_3 x)\, e^{2x} + c_4 \cos x + c_5 \sin x$
(e) $y(x) = e^{-x}(c_1 + c_2 x) + c_3\, e^{2x} + c_4\, e^{-x} \cos x + c_5\, e^{-x} \sin x$

15. An appropriate form of a particular solution y_p for the non-homogeneous differential equation

$$(D^2 - 1)^2\, y = e^x + \sin x$$

is given by $y_p(x) =$

(a) $Ae^x + B\cos x + C\sin x$

(b) $Ax^2e^x + Bx^2\cos x + Cx^2\sin x$

(c) $Ax^2e^x + B\sin x$

(d) $Ax^2e^x + B\cos x + C\sin x$

(e) $Axe^x + B\cos x + C\sin x$

King Fahd University of Petroleum and Minerals
Department of Mathematics

CODE 5 **CODE 5**

MATH 208
Major Exam II
Term 251
11 November 2025
Net Time Allowed: 90 Minutes

Name	

ID		**Sec**	

Check that this exam has 15 questions.

Important Instructions:

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2. Use HB 2.5 pencils only.
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7. When bubbling, make sure that the bubbled space is fully covered.
8. When erasing a bubble, make sure that you do not leave any trace of penciling.

1. If the rank of the matrix $\begin{bmatrix} 1 & 1 & 3 & 3 & 0 \\ -1 & 0 & -2 & -1 & 1 \\ 2 & 3 & 7 & 8 & \alpha \\ -2 & 4 & 0 & 6 & 7 \end{bmatrix}$ is equal to 3, then $\alpha =$

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

2. Given that $y = e^{-x}\cos x$ is a solution of the differential equation $9y^{(3)} + 11y'' + 4y' - 14y = 0$. The general solution of the differential equation is

(a) $y = c_1\, e^{x} + c_2\, e^{-x}\cos x + c_3\, e^{-x}\sin x$
(b) $y = c_1\, e^{-\frac{2}{9}x} + c_2\, e^{-x}\cos x + c_3\, e^{-x}\sin x$
(c) $y = c_1\, e^{-\frac{7}{9}x} + c_2\, e^{-x}\cos x + c_3\, e^{-x}\sin x$
(d) $y = c_1\, e^{\frac{2}{9}x} + c_2\, e^{-x}\cos x + c_3\, e^{-x}\sin x$
(e) $y = c_1\, e^{\frac{7}{9}x} + c_2\, e^{-x}\cos x + c_3\, e^{-x}\sin x$

3. If the solution space of the system

$$\begin{aligned} x_1 - 2x_2 - 3x_3 - 16x_4 &= 0 \\ 2x_1 - 4x_2 + x_3 + 17x_4 &= 0 \\ x_1 - 2x_2 + 3x_3 + 26x_4 &= 0 \end{aligned}$$

Consists of all linear combination of the vectors
$v_1 = (a, 1, 0, b)$ and $v_2 = (c, 0, -7, d)$, then $a + b + c + d =$

(a) -3
(b) 5
(c) -2
(d) 0
(e) -4

4. The general solution of the differential equation

$$(D^5 - 2D^3 - 2D^2 - 3D - 2)\, y = 0 \text{ is}$$

(a) $y(x) = e^{x}(c_1 + c_2 x) + c_3\, e^{2x} + c_4 \cos x + c_5 \sin x$
(b) $y(x) = e^{-x}(c_1 + c_2 x) + c_3\, e^{2x} + c_4 \cos x + c_5 \sin x$
(c) $y(x) = e^{-x}(c_1 + c_2 x) + c_3\, e^{2x} + c_4\, e^{-x} \cos x + c_5\, e^{-x} \sin x$
(d) $y(x) = e^{-x}(c_1 + c_2 x) + c_3 e^{2x} + c_4\, e^{x} \cos x + c_5\, e^{x} \sin x$
(e) $y(x) = c_1 e^{-x} + (c_2 + c_3 x)\, e^{2x} + c_4 \cos x + c_5 \sin x$

5. If $W(x)$ is the Wronkian of the functions

$$f_1(x) = 2x + 3\cos x,\ f_2(x) = 5\cos x,\ f_3(x) = -3x, \text{ then } W(x) =$$

(a) 0
(b) $2x$
(c) $3\ \cos x$
(d) $\sin x$
(e) $-2x$

6. A particular solution of the differential equation

$$y'' - 3y' + 2y = \cos(e^{-x})$$

is given by $y_p(x) =$

(a) $2e^x\ \cos(e^{-x}) + e^{2x}\sin(e^{-x})$
(b) $-e^{2x}\ \cos(e^{-x})$
(c) $2e^{2x}\ \sin(e^{-x})$
(d) $-2e^{2x}\ \cos(e^{-x})$
(e) $e^x\ \cos(e^{-x}) + e^{2x}\sin(e^{-x})$

7. If the matrix $A = \begin{bmatrix} -1 & 3 \\ -2 & 4 \end{bmatrix}$ is diagonalizable with a diagonalizing matrix P and a diagonal matrix D such that $P^{-1}AP = D$, then

(a) $P = [31 - 211002$

(b) $P = [131 - 20120$

(c) $P = [31211002$

(d) $P = [13121002$

(e) $P = [13121002$

8. A linear homogeneous differential equation with real coefficients having the solutions xe^x, $5e^x \cos(3x)$ is

(a) $y^{(4)} + 4y^{(3)} + 15y'' - 22y' + 2y = 0$

(b) $y^{(4)} - 4y^{(3)} + 15y'' - 22y' + 10y = 0$

(c) $y^{(4)} - 10y^{(3)} + 15y'' - 22y' + 16y = 0$

(d) $y^{(4)} - 4y^{(3)} + 15y'' - 20y' + 8y = 0$

(e) $y^{(4)} - 4y^{(3)} + 13y'' - 22y' + 12y = 0$

9. A basis for the subspace of $\mathbb{R}^3$ consists of the line of intersection of the planes $x - 4y + 7z = 0$ and $y = -z$ is given by $v = (\alpha, -1, 1)$ where $\alpha =$

(a) -10

(b) 9

(c) 0

(d) 10

(e) -11

10. An eigenvector associated with the eigenvalue $\lambda = 5$ of the matrix $A = \begin{bmatrix} 5 & 0 \\ 4 & -1 \end{bmatrix}$ is $\begin{bmatrix} 3 \\ \alpha \end{bmatrix}$ where $\alpha =$

(a) -2

(b) 3

(c) -3

(d) 2

(e) 1

11. The characteristic equation of the matrix $\begin{bmatrix} 0 & 1 & -1 \\ -3 & 1 & -3 \\ 1 & -4 & 2 \end{bmatrix}$ is

(a) $\lambda^3 - 4\lambda^2 - 6\lambda + 8 = 0$
(b) $\lambda^3 - 3\lambda^2 - 5\lambda + 6 = 0$
(c) $\lambda^3 - 5\lambda^2 - 6\lambda - 8 = 0$
(d) $\lambda^3 - 3\lambda^2 + 6\lambda - 8 = 0$
(e) $\lambda^3 - 3\lambda^2 - 6\lambda + 8 = 0$

12. If $y_p = Ax^3 + Bx^2 + Cx + D\,\cos x + E\,\sin x$ is a particular solution of the differential equation

$$y''' + 4y' = 24(x^2 + \sin x), \text{ then } A + B + C + D + E =$$

(a) -9
(b) 11
(c) 9
(d) 8
(e) -8

13. If the characteristic polynomial of the matrix

$$A = \begin{bmatrix} 0 & 3 & 1 \\ 1 & 2 & 1 \\ 1 & 3 & 0 \end{bmatrix} \text{ is } p(\lambda) = -(\lambda+1)^2(\lambda-4),$$

then a basis for the eigenspace of $\lambda = -1$ is $v_1 = \begin{bmatrix} \alpha \\ 0 \\ -1 \end{bmatrix}$, $v_2 = \begin{bmatrix} \beta \\ -1 \\ 0 \end{bmatrix}$, where

$\alpha + \beta =$

(a) 3
(b) 2
(c) 4
(d) 0
(e) -4

14. If $y(x)$ is the solution of the initial-value problem

$$(D+2)^2\, y = 0,\ y(0) = 1,\ y'(0) = -1, \text{ then } y\left(\frac{1}{2}\right) =$$

(a) $\frac{5}{e}$
(b) $\frac{5}{2e}$
(c) $\frac{3}{e}$
(d) 0
(e) $\frac{3}{2e}$

15. An appropriate form of a particular solution y_p for the non-homogeneous differential equation

$$(D^2 - 1)^2\, y = e^x + \sin x$$

is given by $y_p(x) =$

(a) $Ax^2e^x + B\cos x + C\sin x$

(b) $Ae^x + B\cos x + C\sin x$

(c) $Ax^2e^x + Bx^2\cos x + Cx^2\sin x$

(d) $Axe^x + B\cos x + C\sin x$

(e) $Ax^2e^x + B\sin x$

King Fahd University of Petroleum and Minerals
Department of Mathematics

CODE 6 **CODE 6**

MATH 208
Major Exam II
Term 251
11 November 2025
Net Time Allowed: 90 Minutes

Name	
ID	
Sec	

Check that this exam has 15 questions.

Important Instructions:

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7. When bubbling, make sure that the bubbled space is fully covered.
8. When erasing a bubble, make sure that you do not leave any trace of penciling.

1. An eigenvector associated with the eigenvalue $\lambda = 5$ of the matrix $A = \begin{bmatrix} 5 & 0 \\ 4 & -1 \end{bmatrix}$ is $\begin{bmatrix} 3 \\ \alpha \end{bmatrix}$ where $\alpha =$

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

2. The general solution of the differential equation

$$(D^5 - 2D^3 - 2D^2 - 3D - 2)\, y = 0 \text{ is}$$

(a) $y(x) = e^{-x}(c_1 + c_2 x) + c_3 e^{2x} + c_4\, e^{x} \cos x + c_5\, e^{x} \sin x$
(b) $y(x) = e^{x}(c_1 + c_2 x) + c_3\, e^{2x} + c_4\, \cos x + c_5\, \sin x$
(c) $y(x) = e^{-x}(c_1 + c_2 x) + c_3\, e^{2x} + c_4\, \cos x + c_5 \sin x$
(d) $y(x) = c_1 e^{-x} + (c_2 + c_3 x)\, e^{2x} + c_4\, \cos x + c_5\, \sin x$
(e) $y(x) = e^{-x}(c_1 + c_2 x) + c_3\, e^{2x} + c_4\, e^{-x} \cos x + c_5\, e^{-x} \sin x$

3. If the characteristic polynomial of the matrix

$$A = \begin{bmatrix} 0 & 3 & 1 \\ 1 & 2 & 1 \\ 1 & 3 & 0 \end{bmatrix} \text{ is } p(\lambda) = -(\lambda+1)^2(\lambda-4),$$

then a basis for the eigenspace of $\lambda = -1$ is $v_1 = \begin{bmatrix} \alpha \\ 0 \\ -1 \end{bmatrix}$, $v_2 = \begin{bmatrix} \beta \\ -1 \\ 0 \end{bmatrix}$, where $\alpha + \beta =$

(a) 4

(b) -4

(c) 3

(d) 0

(e) 2

4. If the solution space of the system

$$\begin{aligned} x_1 - 2x_2 - 3x_3 - 16x_4 &= 0 \\ 2x_1 - 4x_2 + x_3 + 17x_4 &= 0 \\ x_1 - 2x_2 + 3x_3 + 26x_4 &= 0 \end{aligned}$$

Consists of all linear combination of the vectors
$v_1 = (a, 1, 0, b)$ and $v_2 = (c, 0, -7, d)$, then $a + b + c + d =$

(a) 0

(b) -3

(c) -4

(d) -2

(e) 5

5. A particular solution of the differential equation

$$y'' - 3y' + 2y = \cos(e^{-x})$$

is given by $y_p(x) =$

(a) $e^x \cos(e^{-x}) + e^{2x}\sin(e^{-x})$
(b) $-2e^{2x}\cos(e^{-x})$
(c) $2e^{2x}\sin(e^{-x})$
(d) $2e^x \cos(e^{-x}) + e^{2x}\sin(e^{-x})$
(e) $-e^{2x}\cos(e^{-x})$

6. A basis for the subspace of $\mathbb{R}^3$ consists of the line of intersection of the planes $x - 4y + 7z = 0$ and $y = -z$ is given by $v = (\alpha, -1, 1)$ where $\alpha =$

(a) -11
(b) 0
(c) -10
(d) 10
(e) 9

7. If $y(x)$ is the solution of the initial-value problem

$$(D+2)^2\, y = 0,\ y(0) = 1,\ y'(0) = -1, \text{ then } y\left(\frac{1}{2}\right) =$$

(a) 0

(b) $\frac{5}{e}$

(c) $\frac{3}{e}$

(d) $\frac{3}{2e}$

(e) $\frac{5}{2e}$

8. Given that $y = e^{-x}\cos x$ is a solution of the differential equation $9y^{(3)} + 11y'' + 4y' - 14y = 0$. The general solution of the differential equation is

(a) $y = c_1\, e^{-\frac{2}{9}x} + c_2\, e^{-x}\cos x + c_3\, e^{-x}\sin x$

(b) $y = c_1\, e^{-\frac{7}{9}x} + c_2\, e^{-x}\cos x + c_3\, e^{-x}\sin x$

(c) $y = c_1\, e^{x} + c_2\, e^{-x}\cos x + c_3\, e^{-x}\sin x$

(d) $y = c_1\, e^{\frac{2}{9}x} + c_2\, e^{-x}\cos x + c_3\, e^{-x}\sin x$

(e) $y = c_1\, e^{\frac{7}{9}x} + c_2\, e^{-x}\cos x + c_3\, e^{-x}\sin x$

9. A linear homogeneous differential equation with real coefficients having the solutions xe^x, $5e^x\cos(3x)$ is

(a) $y^{(4)} - 10y^{(3)} + 15y'' - 22y' + 16y = 0$

(b) $y^{(4)} + 4y^{(3)} + 15y'' - 22y' + 2y = 0$

(c) $y^{(4)} - 4y^{(3)} + 15y'' - 22y' + 10y = 0$

(d) $y^{(4)} - 4y^{(3)} + 13y'' - 22y' + 12y = 0$

(e) $y^{(4)} - 4y^{(3)} + 15y'' - 20y' + 8y = 0$

10. The characteristic equation of the matrix $\begin{bmatrix} 0 & 1 & -1 \\ -3 & 1 & -3 \\ 1 & -4 & 2 \end{bmatrix}$ is

(a) $\lambda^3 - 3\lambda^2 - 5\lambda + 6 = 0$

(b) $\lambda^3 - 3\lambda^2 - 6\lambda + 8 = 0$

(c) $\lambda^3 - 3\lambda^2 + 6\lambda - 8 = 0$

(d) $\lambda^3 - 4\lambda^2 - 6\lambda + 8 = 0$

(e) $\lambda^3 - 5\lambda^2 - 6\lambda - 8 = 0$

11. If the rank of the matrix $\begin{bmatrix} 1 & 1 & 3 & 3 & 0 \\ -1 & 0 & -2 & -1 & 1 \\ 2 & 3 & 7 & 8 & \alpha \\ -2 & 4 & 0 & 6 & 7 \end{bmatrix}$ is equal to 3, then $\alpha =$

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

12. If $y_p = Ax^3 + Bx^2 + Cx + D\ \cos x + E\ \sin x$ is a particular solution of the differential equation

$$y''' + 4y' = 24(x^2 + \sin x),\ \text{ then } A + B + C + D + E =$$

(a) 11
(b) 8
(c) -8
(d) -9
(e) 9

13. If the matrix $A = \begin{bmatrix} -1 & 3 \\ -2 & 4 \end{bmatrix}$ is diagonalizable with a diagonalizing matrix P and a diagonal matrix D such that $P^{-1}AP = D$, then

(a) $P =$ [131 – 20120

(b) $P =$ [31211002

(c) $P =$ [13121002

(d) $P =$ [31 – 211002

(e) $P =$ [13121002

14. If $W(x)$ is the Wronkian of the functions

$$f_1(x) = 2x + 3\cos x,\ f_2(x) = 5\cos x,\ f_3(x) = -3x, \text{ then } W(x) =$$

(a) $2x$

(b) 0

(c) $3\ \cos x$

(d) $\sin x$

(e) $-2x$

15. An appropriate form of a particular solution y_p for the non-homogeneous differential equation

$$(D^2 - 1)^2 \, y = e^x + \sin x$$

is given by $y_p(x) =$

(a) $Ax^2e^x + Bx^2 \cos x + Cx^2 \sin x$

(b) $Axe^x + B \cos x + C \sin x$

(c) $Ae^x + B \cos x + C \sin x$

(d) $Ax^2e^x + B \sin x$

(e) $Ax^2e^x + B \cos x + C \sin x$

King Fahd University of Petroleum and Minerals
Department of Mathematics

CODE 7 **CODE 7**

MATH 208
Major Exam II
Term 251
11 November 2025
Net Time Allowed: 90 Minutes

Name			
ID		**Sec**	

Check that this exam has 15 questions.

Important Instructions:

1. All types of calculators, smart watches or mobile phones are NOT allowed during the examination.
2. Use HB 2.5 pencils only.
3. Use a good eraser. DO NOT use the erasers attached to the pencil.
4. Write your name, ID number and Section number on the examination paper and in the upper left corner of the answer sheet.
5. When bubbling your ID number and Section number, be sure that the bubbles match with the numbers that you write.
6. The Test Code Number is already bubbled in your answer sheet. Make sure that it is the same as that printed on your question paper.
7. When bubbling, make sure that the bubbled space is fully covered.
8. When erasing a bubble, make sure that you do not leave any trace of penciling.

1. The characteristic equation of the matrix $\begin{bmatrix} 0 & 1 & -1 \\ -3 & 1 & -3 \\ 1 & -4 & 2 \end{bmatrix}$ is

(a) $\lambda^3 - 5\lambda^2 - 6\lambda - 8 = 0$
(b) $\lambda^3 - 3\lambda^2 - 5\lambda + 6 = 0$
(c) $\lambda^3 - 3\lambda^2 + 6\lambda - 8 = 0$
(d) $\lambda^3 - 3\lambda^2 - 6\lambda + 8 = 0$
(e) $\lambda^3 - 4\lambda^2 - 6\lambda + 8 = 0$

2. A particular solution of the differential equation

$$y'' - 3y' + 2y = \cos(e^{-x})$$

is given by $y_p(x) =$

(a) $-e^{2x}\cos(e^{-x})$
(b) $-2e^{2x}\cos(e^{-x})$
(c) $2e^{x}\cos(e^{-x}) + e^{2x}\sin(e^{-x})$
(d) $e^{x}\cos(e^{-x}) + e^{2x}\sin(e^{-x})$
(e) $2e^{2x}\sin(e^{-x})$

3. If the matrix $A = \begin{bmatrix} -1 & 3 \\ -2 & 4 \end{bmatrix}$ is diagonalizable with a diagonalizing matrix P and a diagonal matrix D such that $P^{-1}AP = D$, then

(a) $P = [131 - 20120$

(b) $P = [13121002$

(c) $P = [31 - 211002$

(d) $P = [13121002$

(e) $P = [31211002$

4. The general solution of the differential equation

$$(D^5 - 2D^3 - 2D^2 - 3D - 2)\,y = 0 \text{ is}$$

(a) $y(x) = e^{-x}(c_1 + c_2x) + c_3e^{2x} + c_4\,e^{x}\cos x + c_5\,e^{x}\sin x$

(b) $y(x) = e^{x}(c_1 + c_2x) + c_3\,e^{2x} + c_4\,\cos x + c_5\,\sin x$

(c) $y(x) = e^{-x}(c_1 + c_2x) + c_3\,e^{2x} + c_4\,e^{-x}\cos x + c_5\,e^{-x}\sin x$

(d) $y(x) = c_1e^{-x} + (c_2 + c_3x)\,e^{2x} + c_4\,\cos x + c_5\,\sin x$

(e) $y(x) = e^{-x}(c_1 + c_2x) + c_3\,e^{2x} + c_4\,\cos x + c_5\sin x$

5. If $W(x)$ is the Wronkian of the functions

$$f_1(x) = 2x + 3\cos x,\ f_2(x) = 5\cos x,\ f_3(x) = -3x, \text{ then } W(x) =$$

(a) 0
(b) $2x$
(c) $\sin x$
(d) $3\ \cos x$
(e) $-2x$

6. If $y_p = Ax^3 + Bx^2 + Cx + D\ \cos x + E\ \sin x$ is a particular solution of the differential equation

$$y''' + 4y' = 24(x^2 + \sin x),\ \text{ then } A + B + C + D + E =$$

(a) 11
(b) 8
(c) -9
(d) 9
(e) -8

7. If the characteristic polynomial of the matrix

$$A = \begin{bmatrix} 0 & 3 & 1 \\ 1 & 2 & 1 \\ 1 & 3 & 0 \end{bmatrix} \text{ is } p(\lambda) = -(\lambda+1)^2(\lambda-4),$$

then a basis for the eigenspace of $\lambda = -1$ is $v_1 = \begin{bmatrix} \alpha \\ 0 \\ -1 \end{bmatrix}$, $v_2 = \begin{bmatrix} \beta \\ -1 \\ 0 \end{bmatrix}$, where $\alpha + \beta =$

(a) 0
(b) 3
(c) -4
(d) 4
(e) 2

8. Given that $y = e^{-x}\cos x$ is a solution of the differential equation $9y^{(3)} + 11y'' + 4y' - 14y = 0$. The general solution of the differential equation is

(a) $y = c_1\, e^{x} + c_2\, e^{-x}\cos x + c_3\, e^{-x}\sin x$
(b) $y = c_1\, e^{\frac{7}{9}x} + c_2\, e^{-x}\cos x + c_3\, e^{-x}\sin x$
(c) $y = c_1\, e^{\frac{2}{9}x} + c_2\, e^{-x}\cos x + c_3\, e^{-x}\sin x$
(d) $y = c_1\, e^{-\frac{2}{9}x} + c_2\, e^{-x}\cos x + c_3\, e^{-x}\sin x$
(e) $y = c_1\, e^{-\frac{7}{9}x} + c_2\, e^{-x}\cos x + c_3\, e^{-x}\sin x$

9. If the solution space of the system

$$\begin{aligned} x_1 - 2x_2 - 3x_3 - 16x_4 &= 0 \\ 2x_1 - 4x_2 + x_3 + 17x_4 &= 0 \\ x_1 - 2x_2 + 3x_3 + 26x_4 &= 0 \end{aligned}$$

Consists of all linear combination of the vectors
$v_1 = (a, 1, 0, b)$ and $v_2 = (c, 0, -7, d)$, then $a + b + c + d =$

(a) 0
(b) -2
(c) -4
(d) 5
(e) -3

10. If the rank of the matrix $\begin{bmatrix} 1 & 1 & 3 & 3 & 0 \\ -1 & 0 & -2 & -1 & 1 \\ 2 & 3 & 7 & 8 & \alpha \\ -2 & 4 & 0 & 6 & 7 \end{bmatrix}$ is equal to 3, then $\alpha =$

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

11. If $y(x)$ is the solution of the initial-value problem

$$(D+2)^2\,y = 0,\ y(0) = 1,\ y'(0) = -1,\ \text{then}\, y\left(\frac{1}{2}\right) =$$

(a) $\frac{3}{e}$

(b) $\frac{3}{2e}$

(c) $\frac{5}{e}$

(d) 0

(e) $\frac{5}{2e}$

12. A linear homogeneous differential equation with real coefficients having the solutions xe^x, $5e^x\cos(3x)$ is

(a) $y^{(4)} - 4y^{(3)} + 13y'' - 22y' + 12y = 0$

(b) $y^{(4)} - 4y^{(3)} + 15y'' - 22y' + 10y = 0$

(c) $y^{(4)} - 4y^{(3)} + 15y'' - 20y' + 8y = 0$

(d) $y^{(4)} + 4y^{(3)} + 15y'' - 22y' + 2y = 0$

(e) $y^{(4)} - 10y^{(3)} + 15y'' - 22y' + 16y = 0$

13. An eigenvector associated with the eigenvalue $\lambda = 5$ of the matrix $A = \begin{bmatrix} 5 & 0 \\ 4 & -1 \end{bmatrix}$ is $\begin{bmatrix} 3 \\ \alpha \end{bmatrix}$ where $\alpha =$

(a) 2
(b) 3
(c) −3
(d) 1
(e) −2

14. A basis for the subspace of $\mathbb{R}^3$ consists of the line of intersection of the planes $x - 4y + 7z = 0$ and $y = -z$ is given by $v = (\alpha, -1, 1)$ where $\alpha =$

(a) 9
(b) 10
(c) −11
(d) −10
(e) 0

15. An appropriate form of a particular solution y_p for the non-homogeneous differential equation

$$(D^2 - 1)^2\, y = e^x + \sin x$$

is given by $y_p(x) =$

(a) $Ax^2e^x + B\sin x$

(b) $Axe^x + B\cos x + C\sin x$

(c) $Ax^2e^x + B\cos x + C\sin x$

(d) $Ax^2e^x + Bx^2\cos x + Cx^2\sin x$

(e) $Ae^x + B\cos x + C\sin x$

King Fahd University of Petroleum and Minerals
Department of Mathematics

CODE 8 **CODE 8**

MATH 208
Major Exam II
Term 251
11 November 2025
Net Time Allowed: 90 Minutes

Name	

ID		**Sec**	

Check that this exam has <u>15</u> questions.

Important Instructions:

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6. The Test Code Number is already bubbled in your answer sheet. Make sure that it is the same as that printed on your question paper.
7. When bubbling, make sure that the bubbled space is fully covered.
8. When erasing a bubble, make sure that you do not leave any trace of penciling.

1. If $W(x)$ is the Wronkian of the functions

$$f_1(x) = 2x + 3\cos x,\ f_2(x) = 5\cos x,\ f_3(x) = -3x, \text{ then } W(x) =$$

(a) $3\ \cos x$

(b) $2x$

(c) $\sin x$

(d) $-2x$

(e) 0

2. Given that $y = e^{-x}\cos x$ is a solution of the differential equation $9y^{(3)} + 11y'' + 4y' - 14y = 0$. The general solution of the differential equation is

(a) $y = c_1\, e^{\frac{7}{9}x} + c_2\, e^{-x}\cos x + c_3\, e^{-x}\sin x$

(b) $y = c_1\, e^{x} + c_2\, e^{-x}\cos x + c_3\, e^{-x}\sin x$

(c) $y = c_1\, e^{-\frac{2}{9}x} + c_2\, e^{-x}\cos x + c_3\, e^{-x}\sin x$

(d) $y = c_1\, e^{-\frac{7}{9}x} + c_2\, e^{-x}\cos x + c_3\, e^{-x}\sin x$

(e) $y = c_1\, e^{\frac{2}{9}x} + c_2\, e^{-x}\cos x + c_3\, e^{-x}\sin x$

3. The general solution of the differential equation

$$(D^5 - 2D^3 - 2D^2 - 3D - 2)\, y = 0 \text{ is}$$

(a) $y(x) = e^{-x}(c_1 + c_2 x) + c_3 e^{2x} + c_4\, e^{x} \cos x + c_5\, e^{x} \sin x$
(b) $y(x) = e^{-x}(c_1 + c_2 x) + c_3\, e^{2x} + c_4\, \cos x + c_5 \sin x$
(c) $y(x) = e^{-x}(c_1 + c_2 x) + c_3\, e^{2x} + c_4\, e^{-x} \cos x + c_5\, e^{-x} \sin x$
(d) $y(x) = c_1 e^{-x} + (c_2 + c_3 x)\, e^{2x} + c_4\, \cos x + c_5\, \sin x$
(e) $y(x) = e^{x}(c_1 + c_2 x) + c_3\, e^{2x} + c_4\, \cos x + c_5\, \sin x$

4. The characteristic equation of the matrix $\begin{bmatrix} 0 & 1 & -1 \\ -3 & 1 & -3 \\ 1 & -4 & 2 \end{bmatrix}$ is

(a) $\lambda^3 - 5\lambda^2 - 6\lambda - 8 = 0$
(b) $\lambda^3 - 4\lambda^2 - 6\lambda + 8 = 0$
(c) $\lambda^3 - 3\lambda^2 - 6\lambda + 8 = 0$
(d) $\lambda^3 - 3\lambda^2 - 5\lambda + 6 = 0$
(e) $\lambda^3 - 3\lambda^2 + 6\lambda - 8 = 0$

5. A basis for the subspace of $\mathbb{R}^3$ consists of the line of intersection of the planes $x - 4y + 7z = 0$ and $y = -z$ is given by $v = (\alpha, -1, 1)$ where $\alpha =$

   (a) 10
   (b) -11
   (c) 0
   (d) -10
   (e) 9

6. If the matrix $A = \begin{bmatrix} -1 & 3 \\ -2 & 4 \end{bmatrix}$ is diagonalizable with a diagonalizing matrix P and a diagonal matrix D such that $P^{-1}AP = D$, then

   (a) $P =$ [13121002
   (b) $P =$ [13121002
   (c) $P =$ [131 – 20120
   (d) $P =$ [31 – 211002
   (e) $P =$ [31211002

7. An eigenvector associated with the eigenvalue $\lambda = 5$ of the matrix $A = \begin{bmatrix} 5 & 0 \\ 4 & -1 \end{bmatrix}$ is $\begin{bmatrix} 3 \\ \alpha \end{bmatrix}$ where $\alpha =$

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

8. If the characteristic polynomial of the matrix

$$A = \begin{bmatrix} 0 & 3 & 1 \\ 1 & 2 & 1 \\ 1 & 3 & 0 \end{bmatrix} \text{ is } p(\lambda) = -(\lambda+1)^2(\lambda-4),$$

then a basis for the eigenspace of $\lambda = -1$ is $v_1 = \begin{bmatrix} \alpha \\ 0 \\ -1 \end{bmatrix}$, $v_2 = \begin{bmatrix} \beta \\ -1 \\ 0 \end{bmatrix}$, where $\alpha + \beta =$

(a) 3
(b) 4
(c) 0
(d) -4
(e) 2

9. A particular solution of the differential equation

$$y'' - 3y' + 2y = \cos(e^{-x})$$

is given by $y_p(x) =$

(a) $2e^{2x}\,\sin\left(e^{-x}\right)$
(b) $2e^{x}\,\cos\left(e^{-x}\right) + e^{2x}\sin(e^{-x})$
(c) $e^{x}\,\cos\left(e^{-x}\right) + e^{2x}\sin(e^{-x})$
(d) $-e^{2x}\,\cos\left(e^{-x}\right)$
(e) $-2e^{2x}\,\cos\left(e^{-x}\right)$

10. If the solution space of the system

$$\begin{aligned} x_1 - 2x_2 - 3x_3 - 16x_4 &= 0 \\ 2x_1 - 4x_2 + x_3 + 17x_4 &= 0 \\ x_1 - 2x_2 + 3x_3 + 26x_4 &= 0 \end{aligned}$$

Consists of all linear combination of the vectors
$v_1 = (a, 1, 0, b)$ and $v_2 = (c, 0, -7, d)$, then $a + b + c + d =$

(a) -2
(b) -3
(c) 5
(d) 0
(e) -4

11. If $y_p = Ax^3 + Bx^2 + Cx + D\cos x + E\sin x$ is a particular solution of the differential equation

$$y''' + 4y' = 24(x^2 + \sin x), \text{ then } A + B + C + D + E =$$

(a) 8
(b) -9
(c) -8
(d) 9
(e) 11

12. A linear homogeneous differential equation with real coefficients having the solutions xe^x, $5e^x\cos(3x)$ is

(a) $y^{(4)} - 4y^{(3)} + 15y'' - 22y' + 10y = 0$
(b) $y^{(4)} + 4y^{(3)} + 15y'' - 22y' + 2y = 0$
(c) $y^{(4)} - 4y^{(3)} + 13y'' - 22y' + 12y = 0$
(d) $y^{(4)} - 10y^{(3)} + 15y'' - 22y' + 16y = 0$
(e) $y^{(4)} - 4y^{(3)} + 15y'' - 20y' + 8y = 0$

13. If $y(x)$ is the solution of the initial-value problem

$$(D+2)^2\, y = 0,\ y(0) = 1,\ y'(0) = -1, \text{ then } y\left(\frac{1}{2}\right) =$$

(a) $\frac{5}{e}$

(b) 0

(c) $\frac{5}{2e}$

(d) $\frac{3}{2e}$

(e) $\frac{3}{e}$

14. If the rank of the matrix $\begin{bmatrix} 1 & 1 & 3 & 3 & 0 \\ -1 & 0 & -2 & -1 & 1 \\ 2 & 3 & 7 & 8 & \alpha \\ -2 & 4 & 0 & 6 & 7 \end{bmatrix}$ is equal to 3, then $\alpha =$

(a) 2

(b) 1

(c) 3

(d) 0

(e) -2

15. An appropriate form of a particular solution y_p for the non-homogeneous differential equation

$$(D^2 - 1)^2\, y = e^x + \sin x$$

is given by $y_p(x) =$

(a) $Ax^2e^x + B\cos x + C\sin x$

(b) $Ae^x + B\cos x + C\sin x$

(c) $Axe^x + B\cos x + C\sin x$

(d) $Ax^2e^x + Bx^2\cos x + Cx^2\sin x$

(e) $Ax^2e^x + B\sin x$

Q	MASTER	1	2	3	4	5	6	7	8
1	A	B 6	B 1	D 12	E 4	D 1	C 13	D 12	E 4
2	A	A 7	E 12	D 7	D 12	E 10	C 6	A 11	A 10
3	A	E 15	A 13	C 5	E 10	C 3	A 14	E 15	B 6
4	A	D 1	E 2	C 4	B 8	B 6	D 3	E 6	C 12
5	A	B 3	A 7	B 14	E 13	A 4	E 11	A 4	B 2
6	A	C 4	D 3	E 3	D 2	B 11	A 2	C 8	E 15
7	A	C 13	C 10	A 2	A 11	C 15	D 5	D 14	B 13
8	A	D 12	B 5	D 6	E 7	B 7	E 10	B 10	B 14
9	A	D 8	E 4	C 11	B 14	E 2	C 7	B 3	D 11
10	A	C 11	C 11	C 13	E 3	D 13	B 12	A 1	A 3
11	A	B 5	A 8	B 1	D 5	E 12	A 1	B 5	B 8
12	A	C 14	B 14	E 15	C 15	A 8	D 8	B 7	A 7
13	A	A 2	D 6	B 10	A 1	C 14	B 15	A 13	D 5
14	A	E 10	B 15	C 8	A 6	E 5	B 4	C 2	B 1
15	A	C 9	D 9	E 9	D 9	A 9	E 9	C 9	A 9

Answer Counts

V	A	B	C	D	E
1	2	3	5	3	2
2	3	4	2	3	3
3	1	3	5	3	3
4	3	2	1	4	5
5	3	3	3	2	4
6	3	3	3	3	3
7	4	4	3	2	2
8	4	6	1	2	2

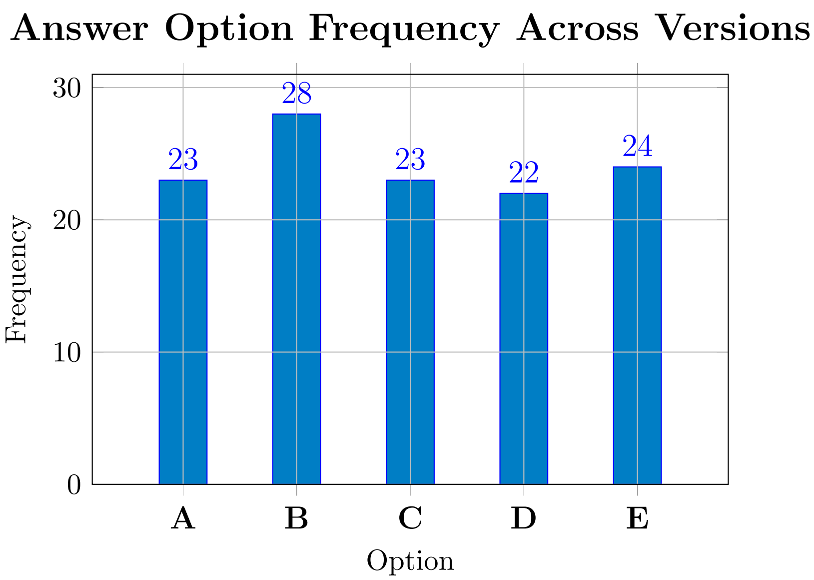

Figure 1: Frequency of Each Answer Option (Excluding MASTER)