King Fahd University of Petroleum and Minerals
Department of Mathematics

Math 208
Exam II
243
20 July 2025

EXAM COVER

Number of versions: 4
Number of questions: 15

King Fahd University of Petroleum and Minerals
Department of Mathematics

Math 208

Exam II

243

20 July 2025

Net Time Allowed: 90 Minutes

MASTER VERSION

1. The rank of the matrix $A = \begin{bmatrix} 3 & 2 & 4 & 1 \\ 2 & 1 & 3 & 2 \\ 2 & 2 & 2 & 3 \\ 2 & 1 & 3 & 4 \end{bmatrix}$ is

(a) 3 ________________ (correct)
(b) 4
(c) 2
(d) 1
(e) 5

2. Consider the subspace S of $\mathbb{R}^4$ defined by
$S = \{(x, y, z, w) | x + 8z = y + 7w = 0\}$. A basis of S consists of the vectors

(a) $\mathbf{v}_1 = (-8, 0, 1, 0)$ and $\mathbf{v}_2 = (0, -7, 0, 1)$ ________________ (correct)
(b) $\mathbf{v}_1 = (8, 0, 1, 0)$ and $\mathbf{v}_2 = (0, -7, 0, 1)$
(c) $\mathbf{v}_1 = (-8, 0, -1, 0)$ and $\mathbf{v}_2 = (0, -7, 0, 1)$
(d) $\mathbf{v}_1 = (-8, 0, 1, 0)$ and $\mathbf{v}_2 = (0, 7, 0, 1)$
(e) $\mathbf{v}_1 = (-8, 0, 1, 0)$ and $\mathbf{v}_2 = (0, -7, 0, -1)$

3. If the solution space of the system

$$\begin{aligned} x_1 + 3x_2 - 4x_3 - 8x_4 + 6x_5 &= 0 \\ x_1 + 2x_3 + x_4 + 3x_5 &= 0 \\ 2x_1 + 7x_2 - 10x_3 - 19x_4 + 13x_5 &= 0 \end{aligned}$$

consists of all linear combination of the three vectors $v_1 = (\alpha, \beta, 1, 0, 0)$ $v_2 = (a, b, 0, 1, 0)$ and $v_3 = (m, n, 0, 0, 1)$ then $\alpha + \beta + a + b + m + n =$

(a) -2 ———————————— (correct)

(b) 3

(c) 1

(d) 4

(e) -3

4. If $W(x)$ is the Wronskian of the functions
$f(x) = x$, $g(x) = \cos(\ln x)$, $h(x) = \sin(\ln x)$, $x > 0$, then $W(x) =$

(a) $\dfrac{2}{x^2}$ ———————————— (correct)

(b) $\dfrac{3}{x^2}$

(c) $\dfrac{2}{x}$

(d) $\dfrac{3}{x}$

(e) $\dfrac{1}{x^3}$

5. If $y(x)$ is the solution of the initial-value problem
$y'' - 10y' + 25y = 0$; $y(0) = 3$, $y'(0) = 13$, then $y(1) =$

(a) e^5 ______________________________ (correct)
(b) $2e^5$
(c) 0
(d) $3e^5$
(e) $4e^5$

6. The general solution of the differential equation $y^{(4)} + y^{(3)} - 3y'' - 5y' - 2y = 0$ is

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

7. A linear homogeneous constant-coefficient differential equation which has the general solution

$$y(x) = (A + Bx + Cx^2)\,\cos 2x + (D + Ex + Fx^2)\,\sin(2x)$$

is

(a) $y^{(6)} + 12y^{(4)} + 48y'' + 64y = 0$ ________________ (correct)
(b) $y^{(6)} - 12y^{(4)} + 48y'' + 64y = 0$
(c) $y^{(6)} + 12y^{(4)} - 48y'' + 64y = 0$
(d) $y^{(6)} + 12y^{(4)} + 48y'' - 64y = 0$
(e) $y^{(6)} - 12y^{(4)} - 48y'' + 64y = 0$

8. If $y_p = A + Bxe^x + Cx^2e^x$ is a particular solution of the differential equation $y'' + 2y' - 3y = 1 + xe^x$, then $9A + 16B =$

(a) -4 ________________ (correct)
(b) 4
(c) 3
(d) -3
(e) 0

9. An appropriate form of a particular solution y_p for the non-homogeneous differential equation $y^{(5)} - y' = (1 + 2x)e^{-x} + 3$ is given by $y_p(x) =$

   (a) $Ax + (Bx + Cx^2)\, e^{-x}$ ——— (correct)

   (b) $A + (B + Cx)\, e^{-x}$

   (c) $Ax^2 + (B + Cx)\, e^{-x}$

   (d) $Ax + (Bx^2 + Cx^3)\, e^{-x}$

   (e) $Ax^2 + (Bx^2 + Cx^3)\, e^{-x}$

10. A particular solution of the differential equation $y'' + 9y = 2\sec(3x)$ is given by $y_p(x) =$

    (a) $\frac{2}{9}\left[3x\sin(3x) + \cos(3x)\,\ln|\cos(3x)|\right]$ ——— (correct)

    (b) $\frac{2}{9}\left[x\sin(3x) + \cos(3x)\,\ln|\cos(3x)|\right]$

    (c) $\frac{2}{9}\left[3x\cos(3x) + x\sin(3x)\right]$

    (d) $\frac{2}{9}\left[3x\sin(3x) + 3x\cos(3x)\right]$

    (e) $\frac{2}{9}\left[3x^2\sin(3x) + 2\cos(3x)\ln|\cos(3x)|\right]$

11. The characteristic polynomial of the matrix $\begin{bmatrix} 1 & 0 & -1 \\ -2 & 3 & -1 \\ -6 & 6 & 0 \end{bmatrix}$ is $p(\lambda) =$

(a) $-\lambda^3 + 4\lambda^2 - 3\lambda$ ________________ (correct)

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

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

(d) $-\lambda^3 + 4\lambda^2 + 3\lambda$

(e) $-\lambda^3 + 4\lambda^2 - 2\lambda$

12. An eigenvector associated with the eigenvalue $\lambda = 5$ of the matrix $A = \begin{bmatrix} 9 & -10 \\ 2 & 0 \end{bmatrix}$ is $\begin{bmatrix} a \\ 2 \end{bmatrix}$ where $a =$

(a) 5 ________________ (correct)

(b) -5

(c) 4

(d) -4

(e) 0

13. If the characteristic polynomial of the matrix

$$A = \begin{bmatrix} 3 & 6 & -2 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \text{ is } p(\lambda) = -(\lambda - 1)^2(\lambda - 3),$$

then a basis for the eigenspace of $\lambda = 1$ is

$$V_1 = \begin{bmatrix} \alpha \\ 1 \\ 0 \end{bmatrix}, V_2 = \begin{bmatrix} \beta \\ 0 \\ 1 \end{bmatrix}, \text{ where } \alpha + \beta =$$

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

14. Given that $y = \cos(2x)$ is a solution of the differential equation $6y^{(4)} + 5y^{(3)} + 25y'' + 20y' + 4y = 0$. The general solution of the differential equation is

(a) $y(x) = c_1 e^{-x/2} + c_2 e^{-x/3} + c_3 \cos(2x) + c_4 \sin(2x)$ ____________________ (correct)
(b) $y(x) = c_1 e^{-x/2} + c_2 e^{-x/4} + c_3 \cos(2x) + c_4 \sin(2x)$
(c) $y(x) = c_1 e^{-x} + c_2 e^{-2x} + c_3 \cos(2x) + c_4 \sin(2x)$
(d) $y(x) = c_1 e^{2x} + c_2 e^{-x} + c_3 \cos(2x) + c_4 \sin(2x)$
(e) $y(x) = c_1 e^{-x/2} + c_2 e^{x} + c_3 \cos(2x) + c_4 \sin(2x)$

15. If the matrix $A = \begin{bmatrix} 5 & -4 \\ 3 & -2 \end{bmatrix}$ is diagonalizable with a diagonalizing matrix P and a diagonal matrix D such that $P^{-1}AP = D$, then

(a) $P = \begin{bmatrix} 1 & 4 \\ 1 & 3 \end{bmatrix}$, $D = \begin{bmatrix} 1 & 0 \\ 0 & 2 \end{bmatrix}$ ____________________(correct)

(b) $P = \begin{bmatrix} 4 & 1 \\ 3 & 1 \end{bmatrix}$, $D = \begin{bmatrix} 1 & 0 \\ 0 & 2 \end{bmatrix}$

(c) $P = \begin{bmatrix} 1 & 4 \\ -1 & 3 \end{bmatrix}$, $D = \begin{bmatrix} 1 & 0 \\ 0 & 2 \end{bmatrix}$

(d) $P = \begin{bmatrix} 1 & 4 \\ 1 & 0 \end{bmatrix}$, $D = \begin{bmatrix} 1 & 0 \\ 0 & 2 \end{bmatrix}$

(e) $P = \begin{bmatrix} 1 & 4 \\ 1 & 3 \end{bmatrix}$, $D = \begin{bmatrix} 3 & 0 \\ 0 & 2 \end{bmatrix}$

King Fahd University of Petroleum and Minerals
Department of Mathematics

CODE01 **CODE01**

Math 208
Exam II
243
20 July 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.
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 $y(x)$ is the solution of the initial-value problem
$y'' - 10y' + 25y = 0$; $y(0) = 3$, $y'(0) = 13$, then $y(1) =$

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

2. An appropriate form of a particular solution y_p for the non-homogeneous differential equation $y^{(5)} - y' = (1 + 2x)e^{-x} + 3$ is given by $y_p(x) =$

(a) $Ax + (Bx + Cx^2)\, e^{-x}$
(b) $Ax + (Bx^2 + Cx^3)\, e^{-x}$
(c) $A + (B + Cx)\, e^{-x}$
(d) $Ax^2 + (B + Cx)\, e^{-x}$
(e) $Ax^2 + (Bx^2 + Cx^3)\, e^{-x}$

3. Consider the subspace S of $\mathbb{R}^4$ defined by
$S = \{(x, y, z, w) | x + 8z = y + 7w = 0\}$. A basis of S consists of the vectors

(a) $\mathbf{v}_1 = (-8, 0, 1, 0)$ and $\mathbf{v}_2 = (0, -7, 0, -1)$
(b) $\mathbf{v}_1 = (-8, 0, -1, 0)$ and $\mathbf{v}_2 = (0, -7, 0, 1)$
(c) $\mathbf{v}_1 = (-8, 0, 1, 0)$ and $\mathbf{v}_2 = (0, 7, 0, 1)$
(d) $\mathbf{v}_1 = (8, 0, 1, 0)$ and $\mathbf{v}_2 = (0, -7, 0, 1)$
(e) $\mathbf{v}_1 = (-8, 0, 1, 0)$ and $\mathbf{v}_2 = (0, -7, 0, 1)$

4. If the solution space of the system

$$\begin{aligned} x_1 + 3x_2 - 4x_3 - 8x_4 + 6x_5 &= 0 \\ x_1 + 2x_3 + x_4 + 3x_5 &= 0 \\ 2x_1 + 7x_2 - 10x_3 - 19x_4 + 13x_5 &= 0 \end{aligned}$$

consists of all linear combination of the three vectors $v_1 = (\alpha, \beta, 1, 0, 0)$ $v_2 = (a, b, 0, 1, 0)$ and $v_3 = (m, n, 0, 0, 1)$ then $\alpha + \beta + a + b + m + n =$

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

5. If $y_p = A + Bxe^x + Cx^2e^x$ is a particular solution of the differential equation $y'' + 2y' - 3y = 1 + xe^x$, then $9A + 16B =$

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

6. If the characteristic polynomial of the matrix

$$A = \begin{bmatrix} 3 & 6 & -2 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \text{ is } p(\lambda) = -(\lambda - 1)^2(\lambda - 3),$$

then a basis for the eigenspace of $\lambda = 1$ is

$$V_1 = \begin{bmatrix} \alpha \\ 1 \\ 0 \end{bmatrix}, V_2 = \begin{bmatrix} \beta \\ 0 \\ 1 \end{bmatrix}, \text{ where } \alpha + \beta =$$

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

7. A particular solution of the differential equation $y'' + 9y = 2\sec(3x)$ is given by $y_p(x) =$

(a) $\frac{2}{9}\left[x\sin(3x) + \cos(3x)\ \ln|\cos(3x)|\right]$

(b) $\frac{2}{9}\left[3x\cos(3x) + x\sin(3x)\right]$

(c) $\frac{2}{9}\left[3x\sin(3x) + \cos(3x)\ \ln|\cos(3x)|\right]$

(d) $\frac{2}{9}\left[3x\sin(3x) + 3x\cos(3x)\right]$

(e) $\frac{2}{9}\left[3x^2\sin(3x) + 2\cos(3x)\ln|\cos(3x)|\right]$

8. The rank of the matrix $A = \begin{bmatrix} 3 & 2 & 4 & 1 \\ 2 & 1 & 3 & 2 \\ 2 & 2 & 2 & 3 \\ 2 & 1 & 3 & 4 \end{bmatrix}$ is

(a) 5

(b) 4

(c) 1

(d) 3

(e) 2

9. A linear homogeneous constant-coefficient differential equation which has the general solution

$$y(x) = (A + Bx + Cx^2)\,\cos 2x + (D + Ex + Fx^2)\,\sin(2x)$$

is

(a) $y^{(6)} + 12y^{(4)} + 48y'' - 64y = 0$
(b) $y^{(6)} + 12y^{(4)} + 48y'' + 64y = 0$
(c) $y^{(6)} - 12y^{(4)} + 48y'' + 64y = 0$
(d) $y^{(6)} + 12y^{(4)} - 48y'' + 64y = 0$
(e) $y^{(6)} - 12y^{(4)} - 48y'' + 64y = 0$

10. If the matrix $A = \begin{bmatrix} 5 & -4 \\ 3 & -2 \end{bmatrix}$ is diagonalizable with a diagonalizing matrix P and a diagonal matrix D such that $P^{-1}AP = D$, then

(a) $P = \begin{bmatrix} 1 & 4 \\ -1 & 3 \end{bmatrix}$, $D = \begin{bmatrix} 1 & 0 \\ 0 & 2 \end{bmatrix}$

(b) $P = \begin{bmatrix} 1 & 4 \\ 1 & 3 \end{bmatrix}$, $D = \begin{bmatrix} 1 & 0 \\ 0 & 2 \end{bmatrix}$

(c) $P = \begin{bmatrix} 1 & 4 \\ 1 & 0 \end{bmatrix}$, $D = \begin{bmatrix} 1 & 0 \\ 0 & 2 \end{bmatrix}$

(d) $P = \begin{bmatrix} 4 & 1 \\ 3 & 1 \end{bmatrix}$, $D = \begin{bmatrix} 1 & 0 \\ 0 & 2 \end{bmatrix}$

(e) $P = \begin{bmatrix} 1 & 4 \\ 1 & 3 \end{bmatrix}$, $D = \begin{bmatrix} 3 & 0 \\ 0 & 2 \end{bmatrix}$

11. If $W(x)$ is the Wronskian of the functions
$f(x) = x$, $g(x) = \cos(\ln x)$, $h(x) = \sin(\ln x)$, $x > 0$, then $W(x) =$

(a) $\frac{3}{x^2}$
(b) $\frac{3}{x}$
(c) $\frac{2}{x}$
(d) $\frac{1}{x^3}$
(e) $\frac{2}{x^2}$

12. The general solution of the differential equation $y^{(4)} + y^{(3)} - 3y'' - 5y' - 2y = 0$ is

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

13. An eigenvector associated with the eigenvalue $\lambda = 5$ of the matrix $A = \begin{bmatrix} 9 & -10 \\ 2 & 0 \end{bmatrix}$ is $\begin{bmatrix} a \\ 2 \end{bmatrix}$ where $a =$

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

14. Given that $y = \cos(2x)$ is a solution of the differential equation $6y^{(4)} + 5y^{(3)} + 25y'' + 20y' + 4y = 0$. The general solution of the differential equation is

(a) $y(x) = c_1 e^{-x/2} + c_2 e^{x} + c_3 \cos(2x) + c_4 \sin(2x)$
(b) $y(x) = c_1 e^{-x} + c_2 e^{-2x} + c_3 \cos(2x) + c_4 \sin(2x)$
(c) $y(x) = c_1 e^{-x/2} + c_2 e^{-x/4} + c_3 \cos(2x) + c_4 \sin(2x)$
(d) $y(x) = c_1 e^{-x/2} + c_2 e^{-x/3} + c_3 \cos(2x) + c_4 \sin(2x)$
(e) $y(x) = c_1 e^{2x} + c_2 e^{-x} + c_3 \cos(2x) + c_4 \sin(2x)$

15. The characteristic polynomial of the matrix $\begin{bmatrix} 1 & 0 & -1 \\ -2 & 3 & -1 \\ -6 & 6 & 0 \end{bmatrix}$ is $p(\lambda) =$

(a) $-\lambda^3 + 4\lambda^2 - 2\lambda$

(b) $-\lambda^3 + 4\lambda^2 - 3\lambda$

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

(d) $-\lambda^3 + 4\lambda^2 + 3\lambda$

(e) $-\lambda^3 + 6\lambda^2 - 3\lambda$

King Fahd University of Petroleum and Minerals
Department of Mathematics

CODE02 **CODE02**

Math 208
Exam II
243
20 July 2025
Net Time Allowed: 90 Minutes

Name	

ID		**Sec**	

Check that this exam has 15 questions.

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

1. The rank of the matrix $A = \begin{bmatrix} 3 & 2 & 4 & 1 \\ 2 & 1 & 3 & 2 \\ 2 & 2 & 2 & 3 \\ 2 & 1 & 3 & 4 \end{bmatrix}$ is

(a) 3
(b) 4
(c) 1
(d) 5
(e) 2

2. The general solution of the differential equation $y^{(4)} + y^{(3)} - 3y'' - 5y' - 2y = 0$ is

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

3. A particular solution of the differential equation $y'' + 9y = 2\sec(3x)$ is given by $y_p(x) =$

(a) $\frac{2}{9}\left[3x\sin(3x) + \cos(3x)\,\ln|\cos(3x)|\right]$

(b) $\frac{2}{9}\left[3x\cos(3x) + x\sin(3x)\right]$

(c) $\frac{2}{9}\left[3x\sin(3x) + 3x\cos(3x)\right]$

(d) $\frac{2}{9}\left[x\sin(3x) + \cos(3x)\,\ln|\cos(3x)|\right]$

(e) $\frac{2}{9}\left[3x^2\sin(3x) + 2\cos(3x)\ln|\cos(3x)|\right]$

4. A linear homogeneous constant-coefficient differential equation which has the general solution

$$y(x) = (A + Bx + Cx^2)\cos 2x + (D + Ex + Fx^2)\sin(2x)$$

is

(a) $y^{(6)} - 12y^{(4)} - 48y'' + 64y = 0$

(b) $y^{(6)} + 12y^{(4)} + 48y'' - 64y = 0$

(c) $y^{(6)} + 12y^{(4)} - 48y'' + 64y = 0$

(d) $y^{(6)} - 12y^{(4)} + 48y'' + 64y = 0$

(e) $y^{(6)} + 12y^{(4)} + 48y'' + 64y = 0$

5. An eigenvector associated with the eigenvalue $\lambda = 5$ of the matrix $A = \begin{bmatrix} 9 & -10 \\ 2 & 0 \end{bmatrix}$ is $\begin{bmatrix} a \\ 2 \end{bmatrix}$ where $a =$

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

6. If the solution space of the system

$$x_1 + 3x_2 - 4x_3 - 8x_4 + 6x_5 = 0$$
$$x_1 + 2x_3 + x_4 + 3x_5 = 0$$
$$2x_1 + 7x_2 - 10x_3 - 19x_4 + 13x_5 = 0$$

   consists of all linear combination of the three vectors $v_1 = (\alpha, \beta, 1, 0, 0)$ $v_2 = (a, b, 0, 1, 0)$ and $v_3 = (m, n, 0, 0, 1)$ then $\alpha + \beta + a + b + m + n =$

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

7. If $y_p = A + Bxe^x + Cx^2e^x$ is a particular solution of the differential equation $y'' + 2y' - 3y = 1 + xe^x$, then $9A + 16B =$

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

8. An appropriate form of a particular solution y_p for the non-homogeneous differential equation $y^{(5)} - y' = (1 + 2x)e^{-x} + 3$ is given by $y_p(x) =$

   (a) $A + (B + Cx)\, e^{-x}$
   (b) $Ax^2 + (B + Cx)\, e^{-x}$
   (c) $Ax^2 + (Bx^2 + Cx^3)\, e^{-x}$
   (d) $Ax + (Bx^2 + Cx^3)\, e^{-x}$
   (e) $Ax + (Bx + Cx^2)\, e^{-x}$

9. If $W(x)$ is the Wronskian of the functions $f(x) = x$, $g(x) = \cos(\ln x)$, $h(x) = \sin(\ln x)$, $x > 0$, then $W(x) =$

(a) $\frac{1}{x^3}$
(b) $\frac{3}{x^2}$
(c) $\frac{3}{x}$
(d) $\frac{2}{x}$
(e) $\frac{2}{x^2}$

10. The characteristic polynomial of the matrix $\begin{bmatrix} 1 & 0 & -1 \\ -2 & 3 & -1 \\ -6 & 6 & 0 \end{bmatrix}$ is $p(\lambda) =$

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

11. If the matrix $A = \begin{bmatrix} 5 & -4 \\ 3 & -2 \end{bmatrix}$ is diagonalizable with a diagonalizing matrix P and a diagonal matrix D such that $P^{-1}AP = D$, then

(a) $P = \begin{bmatrix} 4 & 1 \\ 3 & 1 \end{bmatrix}$, $D = \begin{bmatrix} 1 & 0 \\ 0 & 2 \end{bmatrix}$

(b) $P = \begin{bmatrix} 1 & 4 \\ 1 & 3 \end{bmatrix}$, $D = \begin{bmatrix} 1 & 0 \\ 0 & 2 \end{bmatrix}$

(c) $P = \begin{bmatrix} 1 & 4 \\ 1 & 3 \end{bmatrix}$, $D = \begin{bmatrix} 3 & 0 \\ 0 & 2 \end{bmatrix}$

(d) $P = \begin{bmatrix} 1 & 4 \\ 1 & 0 \end{bmatrix}$, $D = \begin{bmatrix} 1 & 0 \\ 0 & 2 \end{bmatrix}$

(e) $P = \begin{bmatrix} 1 & 4 \\ -1 & 3 \end{bmatrix}$, $D = \begin{bmatrix} 1 & 0 \\ 0 & 2 \end{bmatrix}$

12. If the characteristic polynomial of the matrix

$$A = \begin{bmatrix} 3 & 6 & -2 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \text{ is } p(\lambda) = -(\lambda - 1)^2(\lambda - 3),$$

then a basis for the eigenspace of $\lambda = 1$ is

$$V_1 = \begin{bmatrix} \alpha \\ 1 \\ 0 \end{bmatrix}, V_2 = \begin{bmatrix} \beta \\ 0 \\ 1 \end{bmatrix}, \text{ where } \alpha + \beta =$$

(a) 5

(b) -3

(c) -2

(d) -4

(e) 3

13. Given that $y = \cos(2x)$ is a solution of the differential equation $6y^{(4)} + 5y^{(3)} + 25y'' + 20y' + 4y = 0$. The general solution of the differential equation is

(a) $y(x) = c_1e^{2x} + c_2e^{-x} + c_3\cos(2x) + c_4\sin(2x)$
(b) $y(x) = c_1e^{-x/2} + c_2e^{-x/3} + c_3\cos(2x) + c_4\sin(2x)$
(c) $y(x) = c_1e^{-x/2} + c_2e^{x} + c_3\cos(2x) + c_4\sin(2x)$
(d) $y(x) = c_1e^{-x} + c_2e^{-2x} + c_3\cos(2x) + c_4\sin(2x)$
(e) $y(x) = c_1e^{-x/2} + c_2e^{-x/4} + c_3\cos(2x) + c_4\sin(2x)$

14. Consider the subspace S of $\mathbb{R}^4$ defined by $S = \{(x, y, z, w)|x + 8z = y + 7w = 0\}$. A basis of S consists of the vectors

(a) $\mathbf{v}_1 = (8, 0, 1, 0)$ and $\mathbf{v}_2 = (0, -7, 0, 1)$
(b) $\mathbf{v}_1 = (-8, 0, -1, 0)$ and $\mathbf{v}_2 = (0, -7, 0, 1)$
(c) $\mathbf{v}_1 = (-8, 0, 1, 0)$ and $\mathbf{v}_2 = (0, -7, 0, 1)$
(d) $\mathbf{v}_1 = (-8, 0, 1, 0)$ and $\mathbf{v}_2 = (0, 7, 0, 1)$
(e) $\mathbf{v}_1 = (-8, 0, 1, 0)$ and $\mathbf{v}_2 = (0, -7, 0, -1)$

15. If $y(x)$ is the solution of the initial-value problem
$y'' - 10y' + 25y = 0$; $y(0) = 3$, $y'(0) = 13$, then $y(1) =$

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

King Fahd University of Petroleum and Minerals
Department of Mathematics

CODE03 **CODE03**

Math 208
Exam II
243
20 July 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 Wronskian of the functions
   $f(x) = x$, $g(x) = \cos(\ln x)$, $h(x) = \sin(\ln x)$, $x > 0$, then $W(x) =$

   (a) $\dfrac{3}{x}$
   (b) $\dfrac{2}{x}$
   (c) $\dfrac{2}{x^2}$
   (d) $\dfrac{1}{x^3}$
   (e) $\dfrac{3}{x^2}$

2. An appropriate form of a particular solution y_p for the non-homogeneous differential equation $y^{(5)} - y' = (1 + 2x)e^{-x} + 3$ is given by $y_p(x) =$

   (a) $Ax^2 + (Bx^2 + Cx^3)\, e^{-x}$
   (b) $A + (B + Cx)\, e^{-x}$
   (c) $Ax^2 + (B + Cx)\, e^{-x}$
   (d) $Ax + (Bx + Cx^2)\, e^{-x}$
   (e) $Ax + (Bx^2 + Cx^3)\, e^{-x}$

3. The rank of the matrix $A = \begin{bmatrix} 3 & 2 & 4 & 1 \\ 2 & 1 & 3 & 2 \\ 2 & 2 & 2 & 3 \\ 2 & 1 & 3 & 4 \end{bmatrix}$ is

(a) 1
(b) 3
(c) 2
(d) 4
(e) 5

4. Consider the subspace S of $\mathbb{R}^4$ defined by
$S = \{(x, y, z, w) | x + 8z = y + 7w = 0\}$. A basis of S consists of the vectors

(a) $\mathbf{v}_1 = (-8, 0, 1, 0)$ and $\mathbf{v}_2 = (0, -7, 0, -1)$
(b) $\mathbf{v}_1 = (-8, 0, 1, 0)$ and $\mathbf{v}_2 = (0, 7, 0, 1)$
(c) $\mathbf{v}_1 = (-8, 0, 1, 0)$ and $\mathbf{v}_2 = (0, -7, 0, 1)$
(d) $\mathbf{v}_1 = (8, 0, 1, 0)$ and $\mathbf{v}_2 = (0, -7, 0, 1)$
(e) $\mathbf{v}_1 = (-8, 0, -1, 0)$ and $\mathbf{v}_2 = (0, -7, 0, 1)$

5. An eigenvector associated with the eigenvalue $\lambda = 5$ of the matrix $A = \begin{bmatrix} 9 & -10 \\ 2 & 0 \end{bmatrix}$ is $\begin{bmatrix} a \\ 2 \end{bmatrix}$ where $a =$

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

6. If $y_p = A + Bxe^x + Cx^2e^x$ is a particular solution of the differential equation $y'' + 2y' - 3y = 1 + xe^x$, then $9A + 16B =$

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

7. The general solution of the differential equation $y^{(4)} + y^{(3)} - 3y'' - 5y' - 2y = 0$ is

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

8. A particular solution of the differential equation $y'' + 9y = 2\sec(3x)$ is given by $y_p(x) =$

(a) $\frac{2}{9}\left[x \sin(3x) + \cos(3x)\ \ln|\cos(3x)|\right]$
(b) $\frac{2}{9}\left[3x \sin(3x) + 3x \cos(3x)\right]$
(c) $\frac{2}{9}\left[3x \cos(3x) + x \sin(3x)\right]$
(d) $\frac{2}{9}\left[3x^2 \sin(3x) + 2\cos(3x) \ln|\cos(3x)|\right]$
(e) $\frac{2}{9}\left[3x \sin(3x) + \cos(3x)\ \ln|\cos(3x)|\right]$

9. The characteristic polynomial of the matrix $\begin{bmatrix} 1 & 0 & -1 \\ -2 & 3 & -1 \\ -6 & 6 & 0 \end{bmatrix}$ is $p(\lambda) =$

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

10. A linear homogeneous constant-coefficient differential equation which has the general solution

$$y(x) = (A + Bx + Cx^2)\cos 2x + (D + Ex + Fx^2)\sin(2x)$$

is

(a) $y^{(6)} - 12y^{(4)} - 48y'' + 64y = 0$
(b) $y^{(6)} + 12y^{(4)} - 48y'' + 64y = 0$
(c) $y^{(6)} - 12y^{(4)} + 48y'' + 64y = 0$
(d) $y^{(6)} + 12y^{(4)} + 48y'' - 64y = 0$
(e) $y^{(6)} + 12y^{(4)} + 48y'' + 64y = 0$

11. If the characteristic polynomial of the matrix

$$A = \begin{bmatrix} 3 & 6 & -2 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \text{ is } p(\lambda) = -(\lambda - 1)^2(\lambda - 3),$$

then a basis for the eigenspace of $\lambda = 1$ is

$$V_1 = \begin{bmatrix} \alpha \\ 1 \\ 0 \end{bmatrix}, V_2 = \begin{bmatrix} \beta \\ 0 \\ 1 \end{bmatrix}, \text{ where } \alpha + \beta =$$

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

12. If $y(x)$ is the solution of the initial-value problem
$y'' - 10y' + 25y = 0$; $y(0) = 3$, $y'(0) = 13$, then $y(1) =$

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

13. If the solution space of the system

$$\begin{gathered} x_1 + 3x_2 - 4x_3 - 8x_4 + 6x_5 = 0 \\ x_1 + 2x_3 + x_4 + 3x_5 = 0 \\ 2x_1 + 7x_2 - 10x_3 - 19x_4 + 13x_5 = 0 \end{gathered}$$

consists of all linear combination of the three vectors $v_1 = (\alpha, \beta, 1, 0, 0)$ $v_2 = (a, b, 0, 1, 0)$ and $v_3 = (m, n, 0, 0, 1)$ then $\alpha + \beta + a + b + m + n =$

(a) 4

(b) -3

(c) -2

(d) 1

(e) 3

14. If the matrix $A = \begin{bmatrix} 5 & -4 \\ 3 & -2 \end{bmatrix}$ is diagonalizable with a diagonalizing matrix P and a diagonal matrix D such that $P^{-1}AP = D$, then

(a) $P = \begin{bmatrix} 1 & 4 \\ 1 & 3 \end{bmatrix}$, $D = \begin{bmatrix} 1 & 0 \\ 0 & 2 \end{bmatrix}$

(b) $P = \begin{bmatrix} 1 & 4 \\ -1 & 3 \end{bmatrix}$, $D = \begin{bmatrix} 1 & 0 \\ 0 & 2 \end{bmatrix}$

(c) $P = \begin{bmatrix} 1 & 4 \\ 1 & 3 \end{bmatrix}$, $D = \begin{bmatrix} 3 & 0 \\ 0 & 2 \end{bmatrix}$

(d) $P = \begin{bmatrix} 4 & 1 \\ 3 & 1 \end{bmatrix}$, $D = \begin{bmatrix} 1 & 0 \\ 0 & 2 \end{bmatrix}$

(e) $P = \begin{bmatrix} 1 & 4 \\ 1 & 0 \end{bmatrix}$, $D = \begin{bmatrix} 1 & 0 \\ 0 & 2 \end{bmatrix}$

15. Given that $y = \cos(2x)$ is a solution of the differential equation $6y^{(4)} + 5y^{(3)} + 25y'' + 20y' + 4y = 0$. The general solution of the differential equation is

(a) $y(x) = c_1e^{2x} + c_2e^{-x} + c_3\cos(2x) + c_4\sin(2x)$

(b) $y(x) = c_1e^{-x/2} + c_2e^{x} + c_3\cos(2x) + c_4\sin(2x)$

(c) $y(x) = c_1e^{-x} + c_2e^{-2x} + c_3\cos(2x) + c_4\sin(2x)$

(d) $y(x) = c_1e^{-x/2} + c_2e^{-x/4} + c_3\cos(2x) + c_4\sin(2x)$

(e) $y(x) = c_1e^{-x/2} + c_2e^{-x/3} + c_3\cos(2x) + c_4\sin(2x)$

King Fahd University of Petroleum and Minerals
Department of Mathematics

CODE04 **CODE04**

Math 208
Exam II
243
20 July 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.
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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. A particular solution of the differential equation $y'' + 9y = 2\sec(3x)$ is given by $y_p(x) =$

   (a) $\frac{2}{9}\left[3x^2\sin(3x) + 2\cos(3x)\ln|\cos(3x)|\right]$

   (b) $\frac{2}{9}\left[x\sin(3x) + \cos(3x)\ \ln|\cos(3x)|\right]$

   (c) $\frac{2}{9}\left[3x\sin(3x) + \cos(3x)\ \ln|\cos(3x)|\right]$

   (d) $\frac{2}{9}\left[3x\sin(3x) + 3x\cos(3x)\right]$

   (e) $\frac{2}{9}\left[3x\cos(3x) + x\sin(3x)\right]$

2. An appropriate form of a particular solution y_p for the non-homogeneous differential equation $y^{(5)} - y' = (1+2x)e^{-x} + 3$ is given by $y_p(x) =$

   (a) $A + (B + Cx)\,e^{-x}$

   (b) $Ax + (Bx + Cx^2)\,e^{-x}$

   (c) $Ax + (Bx^2 + Cx^3)\,e^{-x}$

   (d) $Ax^2 + (B + Cx)\,e^{-x}$

   (e) $Ax^2 + (Bx^2 + Cx^3)\,e^{-x}$

3. A linear homogeneous constant-coefficient differential equation which has the general solution

$$y(x) = (A + Bx + Cx^2)\ \cos 2x + (D + Ex + Fx^2)\ \sin(2x)$$

is

(a) $y^{(6)} - 12y^{(4)} + 48y'' + 64y = 0$
(b) $y^{(6)} + 12y^{(4)} + 48y'' + 64y = 0$
(c) $y^{(6)} + 12y^{(4)} - 48y'' + 64y = 0$
(d) $y^{(6)} + 12y^{(4)} + 48y'' - 64y = 0$
(e) $y^{(6)} - 12y^{(4)} - 48y'' + 64y = 0$

4. The general solution of the differential equation $y^{(4)} + y^{(3)} - 3y'' - 5y' - 2y = 0$ is

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

5. Given that $y = \cos(2x)$ is a solution of the differential equation $6y^{(4)} + 5y^{(3)} + 25y'' + 20y' + 4y = 0$. The general solution of the differential equation is

(a) $y(x) = c_1 e^{-x/2} + c_2 e^{-x/4} + c_3 \cos(2x) + c_4 \sin(2x)$
(b) $y(x) = c_1 e^{2x} + c_2 e^{-x} + c_3 \cos(2x) + c_4 \sin(2x)$
(c) $y(x) = c_1 e^{-x/2} + c_2 e^{-x/3} + c_3 \cos(2x) + c_4 \sin(2x)$
(d) $y(x) = c_1 e^{-x} + c_2 e^{-2x} + c_3 \cos(2x) + c_4 \sin(2x)$
(e) $y(x) = c_1 e^{-x/2} + c_2 e^{x} + c_3 \cos(2x) + c_4 \sin(2x)$

6. If the solution space of the system

$$x_1 + 3x_2 - 4x_3 - 8x_4 + 6x_5 = 0$$
$$x_1 + 2x_3 + x_4 + 3x_5 = 0$$
$$2x_1 + 7x_2 - 10x_3 - 19x_4 + 13x_5 = 0$$

consists of all linear combination of the three vectors $v_1 = (\alpha, \beta, 1, 0, 0)$ $v_2 = (a, b, 0, 1, 0)$ and $v_3 = (m, n, 0, 0, 1)$ then $\alpha + \beta + a + b + m + n =$

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

7. If $y_p = A + Bxe^x + Cx^2e^x$ is a particular solution of the differential equation $y'' + 2y' - 3y = 1 + xe^x$, then $9A + 16B =$

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

8. The characteristic polynomial of the matrix $\begin{bmatrix} 1 & 0 & -1 \\ -2 & 3 & -1 \\ -6 & 6 & 0 \end{bmatrix}$ is $p(\lambda) =$

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

9. The rank of the matrix $A = \begin{bmatrix} 3 & 2 & 4 & 1 \\ 2 & 1 & 3 & 2 \\ 2 & 2 & 2 & 3 \\ 2 & 1 & 3 & 4 \end{bmatrix}$ is

(a) 2
(b) 1
(c) 5
(d) 3
(e) 4

10. If $W(x)$ is the Wronskian of the functions
$f(x) = x$, $g(x) = \cos(\ln x)$, $h(x) = \sin(\ln x)$, $x > 0$, then $W(x) =$

(a) $\frac{2}{x}$
(b) $\frac{3}{x^2}$
(c) $\frac{1}{x^3}$
(d) $\frac{2}{x^2}$
(e) $\frac{3}{x}$

11. An eigenvector associated with the eigenvalue $\lambda = 5$ of the matrix $A = \begin{bmatrix} 9 & -10 \\ 2 & 0 \end{bmatrix}$ is $\begin{bmatrix} a \\ 2 \end{bmatrix}$ where $a =$

(a) -5

(b) 5

(c) 4

(d) 0

(e) -4

12. If $y(x)$ is the solution of the initial-value problem $y'' - 10y' + 25y = 0$; $y(0) = 3$, $y'(0) = 13$, then $y(1) =$

(a) $2e^5$

(b) $3e^5$

(c) 0

(d) $4e^5$

(e) e^5

13. Consider the subspace S of $\mathbb{R}^4$ defined by
$S = \{(x, y, z, w) | x + 8z = y + 7w = 0\}$. A basis of S consists of the vectors

(a) $\mathbf{v}_1 = (8, 0, 1, 0)$ and $\mathbf{v}_2 = (0, -7, 0, 1)$
(b) $\mathbf{v}_1 = (-8, 0, -1, 0)$ and $\mathbf{v}_2 = (0, -7, 0, 1)$
(c) $\mathbf{v}_1 = (-8, 0, 1, 0)$ and $\mathbf{v}_2 = (0, -7, 0, 1)$
(d) $\mathbf{v}_1 = (-8, 0, 1, 0)$ and $\mathbf{v}_2 = (0, -7, 0, -1)$
(e) $\mathbf{v}_1 = (-8, 0, 1, 0)$ and $\mathbf{v}_2 = (0, 7, 0, 1)$

14. If the characteristic polynomial of the matrix

$$A = \begin{bmatrix} 3 & 6 & -2 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \text{ is } p(\lambda) = -(\lambda - 1)^2(\lambda - 3),$$

then a basis for the eigenspace of $\lambda = 1$ is

$$V_1 = \begin{bmatrix} \alpha \\ 1 \\ 0 \end{bmatrix}, V_2 = \begin{bmatrix} \beta \\ 0 \\ 1 \end{bmatrix}, \text{ where } \alpha + \beta =$$

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

15. If the matrix $A = \begin{bmatrix} 5 & -4 \\ 3 & -2 \end{bmatrix}$ is diagonalizable with a diagonalizing matrix P and a diagonal matrix D such that $P^{-1}AP = D$, then

(a) $P = \begin{bmatrix} 1 & 4 \\ 1 & 0 \end{bmatrix}$, $D = \begin{bmatrix} 1 & 0 \\ 0 & 2 \end{bmatrix}$

(b) $P = \begin{bmatrix} 1 & 4 \\ 1 & 3 \end{bmatrix}$, $D = \begin{bmatrix} 1 & 0 \\ 0 & 2 \end{bmatrix}$

(c) $P = \begin{bmatrix} 4 & 1 \\ 3 & 1 \end{bmatrix}$, $D = \begin{bmatrix} 1 & 0 \\ 0 & 2 \end{bmatrix}$

(d) $P = \begin{bmatrix} 1 & 4 \\ 1 & 3 \end{bmatrix}$, $D = \begin{bmatrix} 3 & 0 \\ 0 & 2 \end{bmatrix}$

(e) $P = \begin{bmatrix} 1 & 4 \\ -1 & 3 \end{bmatrix}$, $D = \begin{bmatrix} 1 & 0 \\ 0 & 2 \end{bmatrix}$

Q	MASTER	CODE01	CODE02	CODE03	CODE04
1	A	B 5	A 1	C 4	C 10
2	A	A 9	C 6	D 9	B 9
3	A	E 2	A 10	B 1	B 7
4	A	A 3	E 7	C 2	E 6
5	A	D 8	A 12	B 12	C 14
6	A	A 13	E 3	E 8	D 3
7	A	C 10	E 8	D 6	D 8
8	A	D 1	E 9	E 10	B 11
9	A	B 7	E 4	B 11	D 1
10	A	B 15	B 11	E 7	D 4
11	A	E 4	B 15	A 13	B 12
12	A	A 6	C 13	B 5	E 5
13	A	B 12	B 14	C 3	C 2
14	A	D 14	C 2	A 15	E 13
15	A	B 11	D 5	E 14	B 15

Answer Counts

V	A	B	C	D	E
1	4	5	1	3	2
2	3	3	3	1	5
3	2	4	3	2	4
4	0	5	3	4	3