MATH 3350: T/F Practice Questions

The true/false statements below cover a variety of topics from MATH 3350. However, not all topics are covered, so do not use these practice questions as your only study materials. Moreover, note that 107–111, 114–124, 139–147, and 150–154 may not have been covered in MATH 3350.

1. Different sequences of row operations can lead to different echelon forms for the same matrix.
2. If a linear system has four equations and seven variables, then it must have infinitely many solutions.
3. If a linear system has seven equations and four variables, then it must be inconsistent.
4. If a linear system has the same number of equations and variables, then it must have a unique solution.
5. If $m < n$, then a set of m vectors cannot span $\mathbf{R}^n$.
6. If a set of vectors includes $\mathbf{0}$, then is cannot span $\mathbf{R}^n$.
7. Suppose A is a matrix with n rows and m columns. If $n < m$, then the columns of A span $\mathbf{R}^n$.
8. Suppose A is a matrix with n rows and m columns. If $m < n$, then the columns of A span $\mathbf{R}^n$.
9. If A is a matrix with columns that span $\mathbf{R}^n$, then $A\mathbf{x} = \mathbf{b}$ has a solution for all $\mathbf{b}$ in $\mathbf{R}^n$.
10. If $\{\mathbf{u}_1, \mathbf{u}_2, \mathbf{u}_3\}$ does not span $\mathbf{R}^3$, then neither does $\{\mathbf{u}_1, \mathbf{u}_2, \mathbf{u}_3, \mathbf{u}_4\}$.
11. If $\{\mathbf{u}_1, \mathbf{u}_2, \mathbf{u}_3, \mathbf{u}_4\}$ spans $\mathbf{R}^3$, then so does $\{\mathbf{u}_1, \mathbf{u}_2, \mathbf{u}_3\}$.
12. If $\{\mathbf{u}_1, \mathbf{u}_2, \mathbf{u}_3, \mathbf{u}_4\}$ does not span $\mathbf{R}^3$, then neither does $\{\mathbf{u}_1, \mathbf{u}_2, \mathbf{u}_3\}$.
13. If $\mathbf{u}_4$ is a linear combination of $\{\mathbf{u}_1, \mathbf{u}_2, \mathbf{u}_3\}$, then
$$\text{span}\{\mathbf{u}_1, \mathbf{u}_2, \mathbf{u}_3, \mathbf{u}_4\} = \text{span}\{\mathbf{u}_1, \mathbf{u}_2, \mathbf{u}_3\}.$$
14. If $\mathbf{u}_4$ is a linear combination of $\{\mathbf{u}_1, \mathbf{u}_2, \mathbf{u}_3\}$, then
$$\text{span}\{\mathbf{u}_1, \mathbf{u}_2, \mathbf{u}_3, \mathbf{u}_4\} \neq \text{span}\{\mathbf{u}_1, \mathbf{u}_2, \mathbf{u}_3\}.$$
15. If $\mathbf{u}_4$ is *not* a linear combination of $\{\mathbf{u}_1, \mathbf{u}_2, \mathbf{u}_3\}$, then
$$\text{span}\{\mathbf{u}_1, \mathbf{u}_2, \mathbf{u}_3, \mathbf{u}_4\} = \text{span}\{\mathbf{u}_1, \mathbf{u}_2, \mathbf{u}_3\}.$$
16. If $\mathbf{u}_4$ is *not* a linear combination of $\{\mathbf{u}_1, \mathbf{u}_2, \mathbf{u}_3\}$, then
$$\text{span}\{\mathbf{u}_1, \mathbf{u}_2, \mathbf{u}_3, \mathbf{u}_4\} \neq \text{span}\{\mathbf{u}_1, \mathbf{u}_2, \mathbf{u}_3\}.$$
17. If a set of vectors in $\mathbf{R}^n$ is linearly dependent, then the set must span $\mathbf{R}^n$.
18. If $m > n$, then a set of m vectors in $\mathbf{R}^n$ is linearly dependent.
19. If A is a matrix with more rows than columns, then the columns of A are linearly independent.
20. If A is a matrix with more columns than rows, then the columns of A are linearly independent.

21. If A is a matrix with linearly independent columns, then $A\mathbf{x} = \mathbf{0}$ has nontrivial solutions.

22. If A is a matrix with linearly independent columns, then $A\mathbf{x} = \mathbf{b}$ has a solution for all $\mathbf{b}$.

23. If $\{\mathbf{u}_1, \mathbf{u}_2, \mathbf{u}_3\}$ is linearly independent, then so is $\{\mathbf{u}_1, \mathbf{u}_2, \mathbf{u}_3, \mathbf{u}_4\}$.

24. If $\{\mathbf{u}_1, \mathbf{u}_2, \mathbf{u}_3\}$ is linearly dependent, then so is $\{\mathbf{u}_1, \mathbf{u}_2, \mathbf{u}_3, \mathbf{u}_4\}$.

25. If $\{\mathbf{u}_1, \mathbf{u}_2, \mathbf{u}_3, \mathbf{u}_4\}$ is linearly independent, then so is $\{\mathbf{u}_1, \mathbf{u}_2, \mathbf{u}_3\}$.

26. If $\{\mathbf{u}_1, \mathbf{u}_2, \mathbf{u}_3, \mathbf{u}_4\}$ is linearly dependent, then so is $\{\mathbf{u}_1, \mathbf{u}_2, \mathbf{u}_3\}$.

27. If $\mathbf{u}_4$ is a linear combination of $\{\mathbf{u}_1, \mathbf{u}_2, \mathbf{u}_3\}$, then $\{\mathbf{u}_1, \mathbf{u}_2, \mathbf{u}_3, \mathbf{u}_4\}$ is linearly independent.

28. If $\mathbf{u}_4$ is a linear combination of $\{\mathbf{u}_1, \mathbf{u}_2, \mathbf{u}_3\}$, then $\{\mathbf{u}_1, \mathbf{u}_2, \mathbf{u}_3, \mathbf{u}_4\}$ is linearly dependent.

29. If $\mathbf{u}_4$ is *not* a linear combination of $\{\mathbf{u}_1, \mathbf{u}_2, \mathbf{u}_3\}$, then $\{\mathbf{u}_1, \mathbf{u}_2, \mathbf{u}_3, \mathbf{u}_4\}$ is linearly independent.

30. If $\mathbf{u}_4$ is *not* a linear combination of $\{\mathbf{u}_1, \mathbf{u}_2, \mathbf{u}_3\}$, then $\{\mathbf{u}_1, \mathbf{u}_2, \mathbf{u}_3, \mathbf{u}_4\}$ is linearly dependent.

End: Exam 1

31. If A is an invertible $n \times n$ matrix, then the number of solutions to $A\mathbf{x} = \mathbf{b}$ depends on the vector $\mathbf{b}$ in $\mathbf{R}^n$.

32. A must be a square matrix to be invertible.

33. If an $n \times n$ matrix A is singular, then the columns of A must be linearly independent.

34. If the columns of an $n \times n$ matrix A span $\mathbf{R}^n$, then A is singular.

35. If A and B are invertible $n \times n$ matrices, then the inverse of AB is $B^{-1}A^{-1}$.

36. If A and B are invertible $n \times n$ matrices, then the inverse of $A + B$ is $A^{-1} + B^{-1}$.

37. If A is invertible, then $\left(A^{-1}\right)^{-1} = A$.

38. If A is an $n \times n$ matrix and $\mathbf{b} \neq \mathbf{0}$ is in $\mathbf{R}^n$, then the solutions to $A\mathbf{x} = \mathbf{b}$ do not form a subspace.

39. If A is a 5×3 matrix, then null(A) forms a subspace of $\mathbf{R}^5$.

40. If A is a 4×7 matrix, then null(A) forms a subspace of $\mathbf{R}^7$.

41. Let $T : \mathbf{R}^6 \to \mathbf{R}^3$ be a linear transformation. Then ker(T) is a subspace of $\mathbf{R}^6$.

42. Let $T : \mathbf{R}^5 \to \mathbf{R}^8$ be a linear transformation. Then ker(T) is a subspace of $\mathbf{R}^8$.

43. Let $T : \mathbf{R}^2 \to \mathbf{R}^7$ be a linear transformation. Then range(T) is a subspace of $\mathbf{R}^2$.

44. Let $T : \mathbf{R}^3 \to \mathbf{R}^9$ be a linear transformation. Then range(T) is a subspace of $\mathbf{R}^9$.

45. The union of two subspaces of $\mathbf{R}^n$ forms another subspace of $\mathbf{R}^n$.

46. The intersection of two subspaces of $\mathbf{R}^n$ forms another subspace of $\mathbf{R}^n$.

47. Let S_1 and S_2 be subspaces of $\mathbf{R}^n$, and define S to be the set of all vectors of the form $\mathbf{s}_1 + \mathbf{s}_2$, where $\mathbf{s}_1$ is in S_1 and $\mathbf{s}_2$ is in S_2. Then S is a subspace of $\mathbf{R}^n$.

48. Let S_1 and S_2 be subspaces of $\mathbf{R}^n$, and define S to be the set of all vectors of the form $\mathbf{s}_1 - \mathbf{s}_2$, where $\mathbf{s}_1$ is in S_1 and $\mathbf{s}_2$ is in S_2. Then S is a subspace of $\mathbf{R}^n$.

49. The set of integers forms a subspace of $\mathbf{R}$.

50. A subspace $S \neq \{\mathbf{0}\}$ can have a finite number of vectors.

51. If S_1 and S_2 are subsets of $\mathbf{R}^n$ but *not* subspaces, then the union of S_1 and S_2 cannot be a subspace of $\mathbf{R}^n$.

52. If S_1 and S_2 are subsets of $\mathbf{R}^n$ but *not* subspaces, then the intersection of S_1 and S_2 cannot be a subspace of $\mathbf{R}^n$.

53. If $S = \text{span}\{\mathbf{u}_1, \mathbf{u}_2, \mathbf{u}_3\}$, then $\dim(S) = 3$.

54. If a set of vectors $\mathcal{U}$ spans a subspace S, then vectors can be added to $\mathcal{U}$ to create a basis for S.

55. If a set of vectors $\mathcal{U}$ is linearly independent in a subspace S, then vectors can be added to $\mathcal{U}$ to create a basis for S.

56. If a set of vectors $\mathcal{U}$ spans a subspace S, then vectors can be removed from $\mathcal{U}$ to create a basis for S.

57. If a set of vectors $\mathcal{U}$ is linearly independent in a subspace S, then vectors can be removed from $\mathcal{U}$ to create a basis for S.

58. Three nonzero vectors that lie in a plane in $\mathbf{R}^3$ might form a basis for $\mathbf{R}^3$.

59. If S_1 is a subspace of dimension 3 in $\mathbf{R}^4$, then there cannot exist a subspace S_2 of $\mathbf{R}^4$ such that $S_1 \subset S_2 \subset \mathbf{R}^4$ but $S_1 \neq S_2 \neq \mathbf{R}^4$

60. The set $\{\mathbf{0}\}$ forms a basis for the zero subspace.

61. $\mathbf{R}^n$ has exactly one subspace of dimension m for each of $m = 0, 1, 2, \ldots, n$.

62. Let $m > n$. Then $\mathcal{U} = \{\mathbf{u}_1, \mathbf{u}_2, \ldots, \mathbf{u}_m\}$ in $\mathbf{R}^n$ can form a basis for $\mathbf{R}^n$ if the correct $m - n$ vectors are removed from $\mathcal{U}$.

63. Let $m < n$. Then $\mathcal{U} = \{\mathbf{u}_1, \mathbf{u}_2, \ldots, \mathbf{u}_m\}$ in $\mathbf{R}^n$ can form a basis for $\mathbf{R}^n$ if the correct $n - m$ vectors are added to $\mathcal{U}$.

64. If $\{\mathbf{u}_1, \mathbf{u}_2, \mathbf{u}_3\}$ is a basis for $\mathbf{R}^3$, then $\text{span}\{\mathbf{u}_1, \mathbf{u}_2\}$ is a plane.

65. If A is a matrix, then the dimension of the row space of A is equal to the dimension of the column space of A.

66. If A is a square matrix, then $\text{row}(A) = \text{col}(A)$.

67. The rank of a matrix A can not exceed the number of rows of A.

68. If $A\mathbf{x} = \mathbf{b}$ is a consistent linear system, then $\mathbf{b}$ is in $\text{row}(A)$.

69. If A is a 4×13 matrix, then the nullity of A could be equal to 5.

70. Suppose that A is a 9×5 matrix, and that $T(\mathbf{x}) = A\mathbf{x}$ is a linear transformation. Then T can be onto.

71. Suppose that A is a 9×5 matrix, and that $T(\mathbf{x}) = A\mathbf{x}$ is a linear transformation. Then T can be one-to-one.

72. Every matrix A has a determinant.

73. If A is an $n \times n$ matrix with all positive entries, then $\det(A) > 0$.

74. If A is a diagonal matrix, then all of the minors of A are also diagonal.

75. If the cofactors of an $n \times n$ matrix A are all nonzero, then $\det(A) \neq 0$.

76. If A and B are 2×2 matrices, then $\det(A - B) = \det(A) - \det(B)$.

77. Interchanging the rows of a matrix has no effect on its determinant.

78. If $\det(A) \neq 0$, then the columns of A are linearly independent.

79. If E is an elementary matrix, then $\det(E) = 1$.

80. If A and B are $n \times n$ matrices, then $\det(A + B) = \det(A) + \det(B)$.

81. If A is a 3×3 matrix and $\det(A) = 0$, then $\operatorname{rank}(A) = 0$.

82. If A is a 4×4 matrix and $\det(A) = 4$, then $\operatorname{nullity}(A) = 0$.

83. Let A, B, and S be $n \times n$ matrices, and S be invertible. If $B = S^{-1}AS$, then $\det(A) = \det(B)$.

84. If A is an $n \times n$ matrix with all entries equal to 1, then $\det(A) = n$.

85. Suppose that A is a 4×4 matrix, and that B is the matrix obtained by multiplying the third column of A by 2. Then $\det(B) = 2\det(A)$.

86. Cramer's rule can be used to find the solution to any system that has the same number of equations as unknowns.

87. If A is a square matrix with integer entries, then so is $\operatorname{adj}(A)$.

88. If A is a 3×3 matrix, then $\operatorname{adj}(2A) = 2\operatorname{adj}(A)$.

89. If A is a square matrix that has all positive entries, then so does $\operatorname{adj}(A)$.

90. If A is an $n \times n$ matrix with $\det(A) = 1$, then $A^{-1} = \operatorname{adj}(A)$.

91. If A is a square matrix, then $\left(\operatorname{adj}(A)\right)^T = \operatorname{adj}(A^T)$.

92. An eigenvalue λ must be nonzero, but an eigenvector $\mathbf{u}$ can be equal to the zero vector.

93. The dimension of an eigenspace is always less than or equal to the multiplicity of the associated eigenvalue.

94. If $\mathbf{u}$ is a nonzero eigenvector of A, then $\mathbf{u}$ and $A\mathbf{u}$ point in the same direction.

95. If λ_1 and λ_2 are eigenvalues of a matrix, then so is $\lambda_1 + \lambda_2$.

96. If A is a diagonal matrix, then the eigenvalues of A lie along the diagonal.

97. If 0 is an eigenvalue of A, then $\operatorname{nullity}(A) > 0$.

98. If 0 is the only eigenvalue of A, then A must be the zero matrix.

End: Exam 2

99. If each eigenspace of A has dimension equal to the multiplicity of the associated eigenvalue, then A is diagonalizable.

100. If an $n \times n$ matrix A has n distinct eigenvectors, then A is diagonalizable.

101. If A is not invertible, then A is not diagonalizable.

102. If A is diagonalizable, then so is A^T.

103. If A is a diagonalizable $n \times n$ matrix, then $\operatorname{rank}(A) = n$.

104. If A and B are diagonalizable $n \times n$ matrices, then so is AB.

105. If A and B are diagonalizable $n \times n$ matrices, then so is $A + B$.

106. If A is a diagonalizable $n \times n$ matrix, then there exist eigenvectors of A that form a basis for $\mathbf{R}^n$.

107. Vectors must be columns of numbers.

108. A set of vectors $\mathcal{V}$ in a vector space V can be linearly independent or can span V, but cannot do both.

109. Suppose that f and g are linearly dependent functions in $C[1, 4]$. If $f(1) = -3g(1)$, then it must be that $f(4) = -3g(4)$.

110. Let $\{\mathbf{v}_1, \ldots, \mathbf{v}_k\}$ be a linearly independent subset of a vector space V. If $c \neq 0$ is a scalar, then $\{c\mathbf{v}_1, \ldots, c\mathbf{v}_k\}$ is also linearly independent.

111. Suppose that $\mathcal{V}_1 \subset \mathcal{V}_2$ are sets in a vector space V. If $\mathcal{V}_2$ spans V, then so does $\mathcal{V}_1$.

112. Let $\{\mathbf{v}_1, \ldots, \mathbf{v}_k\}$ be a linearly independent subset of a vector space V. For any $\mathbf{v} \neq \mathbf{0}$ in V, the set $\{\mathbf{v} + \mathbf{v}_1, \ldots, \mathbf{v} + \mathbf{v}_k\}$ is also linearly independent.

113. If $\{\mathbf{v}_1, \mathbf{v}_2, \mathbf{v}_3\}$ is a linearly independent set, then so is $\{\mathbf{v}_1, \mathbf{v}_2 - \mathbf{v}_1, \mathbf{v}_3 - \mathbf{v}_2 + \mathbf{v}_1\}$.

114. If $\mathcal{V}_1$ and $\mathcal{V}_2$ are linearly independent subsets of a vector space V, then so is $\mathcal{V}_1 \cap \mathcal{V}_2$.

115. The size of a vector space basis varies from one basis to another.

116. There is no linearly independent subset $\mathcal{V}$ of $\mathbf{P}^5$ containing 7 elements.

117. No two vector spaces can share the same dimension.

118. If V is a vector space with $\dim(V) = 6$ and S is a subspace of V with $\dim(S) = 6$, then $S = V$.

119. If V is a finite dimensional vector space, then V cannot contain an infinite linearly independent subset $\mathcal{V}$.

120. If V_1 and V_2 are vector spaces and $\dim(V_1) < \dim(V_2)$, then $V_1 \subset V_2$.

121. If $\mathcal{V}$ spans a vector space V, then vectors can be added to $\mathcal{V}$ to produce a basis for V.

122. If V is a finite dimensional vector space, then every subspace of V must also be finite dimensional.

123. If $\{\mathbf{v}_1, \ldots, \mathbf{v}_k\}$ is a basis for a vector space V, then so is $\{c\mathbf{v}_1, \ldots, c\mathbf{v}_k\}$, where c is a scalar.

124. If S_1 is a subspace of a vector space V and $\dim(S_1) = 1$, then the only proper subspace of S_1 is $S_2 = \{\mathbf{0}\}$.

125. If $\|\mathbf{u} - \mathbf{v}\| = 3$, then the distance between $2\mathbf{u}$ and $2\mathbf{v}$ is 12.

126. If $\mathbf{u}$ and $\mathbf{v}$ in $\mathbf{R}^n$ have nonnegative entries, then $\mathbf{u} \cdot \mathbf{v} \geq 0$.

127. $\|\mathbf{u} + \mathbf{v}\| = \|\mathbf{u}\| + \|\mathbf{v}\|$ for all $\mathbf{u}$ and $\mathbf{v}$ in $\mathbf{R}^n$.

128. Suppose that $\{\mathbf{s}_1, \mathbf{s}_2, \mathbf{s}_3\}$ is an orthogonal set, and that c_1, c_2, and c_3 are scalars. Then $\{c_1\mathbf{s}_1, c_2\mathbf{s}_2, c_3\mathbf{s}_3\}$ is also an orthogonal set.

129. If A is an $n \times n$ matrix and $\mathbf{u}$ is in $\mathbf{R}^n$, then $\|\mathbf{u}\| \leq \|A\mathbf{u}\|$.

130. If $\mathbf{u}_1 \cdot \mathbf{u}_2 = 0$ and $\mathbf{u}_2 \cdot \mathbf{u}_3 = 0$, then $\mathbf{u}_1 \cdot \mathbf{u}_3 = 0$.

131. If $\|\mathbf{u} - \mathbf{v}\| = \|\mathbf{u} + \mathbf{v}\|$, then $\mathbf{u}$ and $\mathbf{v}$ are orthogonal.

132. If $\mathbf{u}$ is in $\mathbf{R}^5$ and S is a 3-dimensional subspace of $\mathbf{R}^5$, then $\text{proj}_S\mathbf{u}$ is in $\mathbf{R}^3$.

133. If S is a subspace, then $\text{proj}_S\mathbf{u}$ is in S.

134. If $\mathbf{u}$ and $\mathbf{v}$ are vectors, then $\text{proj}_\mathbf{v}\mathbf{u}$ is a multiple of $\mathbf{u}$.

135. If $\mathbf{u}$ and $\mathbf{v}$ are orthogonal, then $\text{proj}_\mathbf{v}\mathbf{u} = \mathbf{0}$.

136. If $\text{proj}_S\mathbf{u} = \mathbf{u}$, then $\mathbf{u}$ is in S.

137. For a vector $\mathbf{u}$ and a subspace S, $\text{proj}_S\big(\text{proj}_S\mathbf{u}\big) = \text{proj}_S\mathbf{u}$.

138. For vectors $\mathbf{u}$ and $\mathbf{v}$, $\text{proj}_\mathbf{u}\big(\text{proj}_\mathbf{v}\mathbf{u}\big) = \mathbf{u}$.

139. If $T : V \to W$ is a linear transformation, then $T(\mathbf{v}_1 - \mathbf{v}_2) = T(\mathbf{v}_1) - T(\mathbf{v}_2)$.

140. If $T : V \to W$ is a linear transformation, then $T(\mathbf{v}) = \mathbf{0}_W$ implies that $\mathbf{v} = \mathbf{0}_V$.

141. If $T : V \to W$ is a linear transformation, then $\dim\big(\ker(T)\big) \leq \dim\big(\text{range}(T)\big)$.

142. If $T : V \to W$ is a linear transformation and $\{\mathbf{v}_1, \cdots, \mathbf{v}_k\}$ is a linearly independent set, then so is $\{T(\mathbf{v}_1), \cdots, T(\mathbf{v}_k)\}$.

143. If $T : V \to W$ is a linear transformation and $\{\mathbf{v}_1, \cdots, \mathbf{v}_k\}$ is a linearly dependent set, then so is $\{T(\mathbf{v}_1), \cdots, T(\mathbf{v}_k)\}$.

144. If $T : \mathbf{R}^{2\times 2} \to \mathbf{P}^6$, then is it impossible for T to be onto.

145. If $T : \mathbf{P}^4 \to \mathbf{R}^6$, then is it impossible for T to be one-to-one.

146. Let $T : V \to W$ be a linear transformation and $\mathbf{w}$ a nonzero vector in W. Then the set of all $\mathbf{v}$ in V such that $T(\mathbf{v}) = \mathbf{w}$ forms a subspace.

147. If $\langle \mathbf{u}, \mathbf{v} \rangle = 3$, then $\langle 2\mathbf{u}, -4\mathbf{v} \rangle = -24$.

148. If $\mathbf{u}$ and $\mathbf{v}$ are orthogonal with $\|\mathbf{u}\| = 3$ and $\|\mathbf{v}\| = 4$, then $\|\mathbf{u} + \mathbf{v}\| = 5$.

149. If $\mathbf{u} = c\mathbf{v}$ for a scalar c, then $\mathbf{u} = \text{proj}_\mathbf{u}\mathbf{v}$

150. If $\{\mathbf{u}, \mathbf{v}\}$ is an orthogonal set and c_1 and c_2 are scalars, then $\{c_1\mathbf{u}, c_2\mathbf{v}\}$ is also an orthogonal set.

151. $-\|\mathbf{u}\|\|\mathbf{v}\| \leq \langle \mathbf{u}, \mathbf{v} \rangle$ for all $\mathbf{u}$ and $\mathbf{v}$ in V.

152. $\|\mathbf{u} - \mathbf{v}\| \leq \|\mathbf{u}\| - \|\mathbf{v}\|$ for all $\mathbf{u}$ and $\mathbf{v}$ in V.

153. $\langle f, g \rangle = \int_{-1}^{1} x f(x) g(x)\, dx$ is an inner product on $C[-1, 1]$.

154. If $T : V \to \mathbf{R}^n$ is a linear transformation, then $\langle \mathbf{u}, \mathbf{v} \rangle = T(\mathbf{u}) \cdot T(\mathbf{v})$ is an inner product.

Answers

The answers given below are thought to be correct, but errors can occur. No warranty is given!

1. T
2. F
3. F
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152. F
153. F
154. F