are strictly forbidden.

Part I (24%)	Part II (13%)	Part III (13%)	Total (50%)

Part – I: Multiple-Choice Questions

Choose the best answer from the suggested options and write the letter of your choice.

Each of the correct answers is worth 1.5 points.

1. ...and $q \Rightarrow p$ are true statements, which of the following statements can be false?
   A. $p \vee q$ B. $p \vee (q \wedge p)$ C. $p \Leftrightarrow q$ D. $\neg p \Rightarrow \neg q$
2. The negation of "If $1 > 3$, then 2 is prime" is
   A. $1 > 3$ or 2 is not prime C. $1 > 3$ and 2 is not prime
   B. $1 \leq 3$ or 2 is prime D. $1 \leq 3$ and 2 is not prime
3. A conditional statement $p \Rightarrow q$ is equivalent to its
   A. converse C. inverse
   B. contrapositive D. None of these
4. Which of the following is a true statement on the set of real numbers?
   A. $(\exists x)(x^2 + 1 = 0)$ C. $(\exists x)(\forall y)(x + y = 3)$
   B. $(\forall x)(\exists y)(x + y = 3)$ D. $(\forall x)(\forall y)(x + y = 3)$
5. For any set A, which of the following is not always true?
   A. $\emptyset \subset \{\emptyset\}$ B. $\{\emptyset\} \subset \{\{\emptyset\}, \emptyset\}$ C. $\emptyset \subset A$ D. $\emptyset \in P(A)$
6. Let $A \subseteq B$ for two sets A and B. Which of the following is **not** necessarily true?
   A. $A \setminus B = \emptyset$ B. $A \cap B = A$

C. $(B \setminus A) \cup A = B$ D. $B \setminus A = \varnothing$

7. In the set of integers, the solution set of the inequality $3 < 1 - 2x \leq 7$ is
   A. $\{2, 3\}$ C. $\{-3, -2\}$
   B. $\{0, 1, 2, 3, \ldots\}$ D. $\{\ldots, -5, -4, -3\}$

8. The solution set of the equation $\frac{2}{x+3} + 4 = \frac{x+5}{x+3}$ is
   A. $\varnothing$ B. $\Re \setminus \{-3\}$ C. $\Re$ D. $\{-3\}$

9. Let $A = \{1,2,3,4,\ldots\}$ be a set and $R = \{(x, y) \mid x + 2y = 9;\ x, y \in A\}$ be a relation. Which of the following statements is true about the relation R?
   A. $(5,-1) \in R$ C. $R = A \times A$
   B. $\text{Dom}\, R = A$ D. $\text{Dom}\, R = \{1,3,5,7\}$

10. Which of the following is **not** a factor of the polynomial $x^4 - x^3 - 7x^2 + x + 6$?
    A. $x - 3$ B. $x + 1$ C. $x - 2$ D. $x + 2$

11. Which of the following is **not** true about $f(x) = \frac{x-2}{x-1}$?
    A. 1 is in the range of f C. $f^{-1}(x) = f(x)$
    B. The range of f is $\Re \setminus \{1\}$ D. The domain of f is $\Re \setminus \{1\}$

12. Which of the following is **not** true about the function $f(x) = 2^{-x}$?
    A. Its range is $(0, \infty)$. C. $f(x) \geq 1$ for each $x \geq 0$.
    B. It is a decreasing function. D. Its graph lies above $l : y = 0$.

13. If $A = \begin{bmatrix} 1 & -1 \\ -3 & 2 \end{bmatrix}$ and $B = \begin{bmatrix} -1 & 1 \\ 3 & -2 \end{bmatrix}$, then $A^t + B$ is equal to
    A. $\begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix}$ B. $\begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}$ C. $\begin{bmatrix} 2 & -2 \\ -6 & 4 \end{bmatrix}$ D. $\begin{bmatrix} 0 & -2 \\ 2 & 0 \end{bmatrix}$

14. Given the matrix $A = \begin{bmatrix} 0 & 2 \\ 2 & 0 \end{bmatrix}$, which one is equal to A^2 ?
    A. $\begin{bmatrix} 0 & 4 \\ 4 & 0 \end{bmatrix}$ B. $\begin{bmatrix} 4 & 0 \\ 0 & 4 \end{bmatrix}$ C. $\begin{bmatrix} 4 & 4 \\ 0 & 4 \end{bmatrix}$ D. $\begin{bmatrix} 8 & 0 \\ 4 & 8 \end{bmatrix}$

15. If A and B are symmetric matrices of the same order and k is a scalar, which of the following is **not always** symmetric?
    A. kA B. $A + B$ C. $A - B$ D. AB

16. Which of the following square matrices has a nonzero determinant?
    A. A matrix with a zero row C. A matrix with two equal rows
    B. An invertible matrix D. A zero matrix

Part – II: Short Answer Questions

Give the precise short answer. Do not justify your answers. Each of the correct answers is worth 1 point.

17. Write true "T" if the statement is correct or false "F" otherwise.

a. The compound proposition $p \Leftrightarrow \neg p$ is neither a tautology nor a contradiction.

b. Let A be a set such that $x \in A$. If $A \subset B$, then $x \in B \setminus A$.

c. The function $g = \{(-2,3),(-1,4),(0,2),(1,5)\}$ from $A = \{-2,-1,0,1\}$ to $B = \{2,3,4,5\}$ is a one-to-one correspondence.

d. Every polynomial function of degree $n \geq 1$ has exactly n zeros in $\Re$.

e. The function $g(x) = 2^x$ is the inverse of $f(x) = \log_2 x$.

f. The matrix $A = \begin{bmatrix} 2 & 3 & -1 \\ 0 & 1 & 2 \\ 0 & 0 & 0 \end{bmatrix}$ is invertible.

18. Fill the most simplified answer in the blank space.

a. If $(5^x)^3 8^x = 10^{2x-4}$, then the value of x is equal to _____

b. If $A \cap B = \{3,6\}$ and $A \cap C = \{4,6,8\}$, then $A \cap (B \cup C) =$ _____

c. The solution set of the equation $3x^2 - 4x = 15$ _____

d. Let $A = \begin{bmatrix} 2 & 5 \\ -3 & 1 \end{bmatrix}$ and $B = \begin{bmatrix} 4 & -5 \\ 3 & k \end{bmatrix}$. What value(s) of k, if any, will make $AB = BA$?

_____

e. If $A = \begin{bmatrix} 1 & 2 \\ 3 & -1 \end{bmatrix}$ and $B = \begin{bmatrix} 2 & 0 \\ 1 & 2 \end{bmatrix}$ are two given matrices, then find $\det(ABA^t)$?

_____

f. Let $A = \begin{bmatrix} 1 & 2 & -3 \\ 2 & 1 & 4 \\ 0 & 2 & -3 \end{bmatrix}$ be a matrix. Then

- ✓ the determinant of A is _____
- ✓ the rank of A is equal to _____

Workout Problems

Attempt each of the following questions by showing all necessary steps clearly on the space provided only.

19. Identify the premises, write the argument form and investigate the validity of the following argument.

If he studies medicine, he will get a good job. If he gets a good job, he will get a good wage. He did not get a good wage. Therefore, he did not study medicine. [4 points]

20. Given two functions $f = \{(2,0),(3,-1)\}$ and $g = \{(a,2),(b,3),(c,4)\}$, det

a. $f \circ g$ [2 points]

b. $g \circ f$ [2

21. Solve the system of equations

$$x + 2y + z = 2$$
$$3x + y - 2z = 1 \quad [5 \textit{ points}]$$
$$4x - 3y - z = 3$$