School of Technology and Computer Science

Instructions for the written test

There are two streams in the School of Technology and Computer Science:


Topics covered in the two streams, as well as some sample questions, are given below.

The question paper will have three parts. Part A is common to both the streams. It will test the general mathematical aptitude of the candidate. There is no prescribed syllabus for Part A. Part B will be oriented towards the topics listed under ‘Computer Science’ below; and Part C will be oriented towards topics listed under ‘Systems Science’ below. Only one of Parts B, C, should be attempted. The duration of the written test will be three hours. The test will be of multiple choice type, with negative marking for incorrect answers. The use of calculators will not be allowed during the test.

Computer Science

1. Discrete Mathematics: Sets and Relations, Combinatorics (Counting) and Elementary Probability Theory, Graph Theory, Propositional and Predicate Logic.

2. Formal Languages, Automata Theory and Computability.


4. Fundamentals of Programming Languages and Compilers: Control structures, Parameter passing mechanisms, Recursion, Parsing and type checking, Memory management.

5. Operating Systems and Concurrency

6. Switching Theory and Digital Circuits

7. Theory of Databases
Sample Questions [Computer Science]

1. A function \( f : \{0, 1\}^n \to \{0, 1\} \) is called symmetric if for every \( x_1, x_2, \ldots, x_n \in \{0, 1\} \) and every permutation \( \sigma \) of \( \{1, 2, \ldots, n\} \), we have
\[
f(x_1, x_2, \ldots, x_n) = f(x_{\sigma(1)}, x_{\sigma(2)}, \ldots, x_{\sigma(n)}).
\]
The number of such symmetric functions is:
(a) \( 2^{n+1} \)  (b) \( 2^n \)  (c) \( 2^{2^n}/n! \)  (d) \( 2^{2^n} \)  (e) \( n! \)

2. Let \( r, s \) and \( t \) be regular expressions. Which of the following is wrong?
(a) \( (r + s)^* = (r^*s^*)^* \)  (b) \( r(s + t) = rs + rt \)
(c) \( (r + s)^* = (s + r)^* \)  (d) \( (rs + r)^*r = r(sr + r)^* \)  (e) All are correct.

3. Consider the following program
\[
x:=0; y:=1; z:=1;
\text{while } y < \not= N \text{ do}
\text{begin}
x:=x+1; y:=y+z+2; z:=z+2;
\text{end}
\]
Which of the following holds on termination of the program?
(a) \( (x + 1)^2 = N \)  (b) \( x = \sqrt{N} \)
(c) \( x^2 = N \)  (d) \( x^2 \leq N < (x + 1)^2 \)  (e) \( x^2 < N \leq (x + 1)^2 \).

4. The maximum height of a rooted binary tree (all nodes have either two children or none) with \( N \) nodes is
(a) \( N \)  (b) \( \log N \)  (c) \( (N - 1)/2 \)  (d) \( (N^2)/2 \)  (e) \( N(N - 1)/2 \).

5. If a graph \( G \) has \( n \) vertices and \( m \) edges then the depth first traversal of \( G \) can be carried out in time
(a) \( O(n + m) \)  (b) \( O(nm) \) but not \( O(n + m) \)
(c) \( O(n^2) \) but not \( O(n + m) \)  (d) \( O(n) \)  (e) \( O(m) \)

Systems Science


Sample Questions [Systems Science]

1. The probability density of a random variable is
   \[ f(x) = ax^2 \exp^{-kx} \quad (k > 0, 0 \leq x \leq \infty) \]
   Then, the coefficient \( a \) equals
   (a) \( k^3/2 \)  (b) \( k^3 \)  (c) \( k^2 \)  (d) \( k \)  (e) \( 2k/\pi \).

2. Discrete sequences \( x(n) \) is non-zero for \( 0 \leq n \leq N_x \) and \( y(n) \) for \( 0 \leq n \leq N_y \). The sequence \( z(n) \) is obtained by convolving \( x(n) \) and \( y(n) \). \( z(n) \) assumes nonzero values for \( N_1 \leq n \leq N_2 \), where \( N_1 \) and \( N_2 \) can be expressed in terms of \( N_x \) and \( N_y \) as,
   (a) \( N_1 = 0; N_2 = \text{MAX}(N_x, N_y) \)
   (b) \( N_1 = N_x; N_2 = N_y \)
   (c) \( N_1 = \text{MIN}(N_x, N_y); N_2 = N_x + N_y \)
   (d) \( N_1 = 0; N_2 = N_x + N_y \)
   (e) \( N_1 = \text{MIN}(N_x, N_y); N_2 = \text{MAX}(N_x, N_y) \)

3. This is a portion of FORTRAN-77 program for assigning values to a \( N \times N \) matrix \( A \):
   
   ```fortran
   DO I=1,N
     DO J=I,N
       A(I,J) = ABS(I-J)+1
     ENDDO
   ENDDO
   
   ENDDO```
   What is the matrix \( A \) called ?
   (a) Anti-symmetric  (b) Sparse  (c) Upper triangular  (d) Toeplitz  (e) Irregular.

4. \( \log_b(\log_b x) \) equals
   (a) \( (\ln \ln x - \ln \ln b) / \ln b \)
   (b) \( (\ln x - \ln b) / \ln b \)
   (c) \( (\ln \ln x - \ln \ln b) \)
   (d) \( (\ln x - \ln b) / [(\ln x)(\ln b)] \)
   (e) None of the Above.

5. The Laplace Transform \( G(s) \) of the transfer function of a linear time invariant system is given by
   \[ G(s) = \frac{1}{(s + a)^2 + b^2} \]
   For the system to be stable it is necessary that
   (a) \( a < 0 \)  (b) \( a \geq 0 \)  (c) \( a = b \)  (d) \( b = 0 \)  (e) \( a = -b \).