Dhirubhai Ambani Institute of Information and Communication Technology
Ph.D. Entrance Test (Sample Questions)
Engineering Disciplines

Application No. **Name:**
Subject paper: (Choose one) CSE/ECE

Instructions

1. The question paper has two parts. Part I is mandatory. In Part II, you can attempt any ONE of the following two subject papers: Computer Science and Engineering (CSE) or Electronics and Communication Engineering (ECE).

2. Note that this paper contains only a few sample questions from courses/areas mentioned in the syllabus. The format of the question paper may change, the candidates are requested to only focus on the questions.

3. The actual question paper will have 40 questions. Each question carries 2 marks. Total: 80 marks.

4. Calculator is allowed. Cellular phone and other electronic gadgets are NOT allowed in the examination hall.

Discrete Structures

1. There are $\boxed{}$ functions and $\boxed{}$ binary relations from $\{1, 2, \ldots, 5\}$ to $\{1, 2, \ldots, 100\}$.

Ans: 100^5, 2^{500}.

2. Let $P(x, y)$ be a predicate defined as $P(x, y) : (x \vee y) \to z$. The negation of $\forall x \exists y P(x, y)$ without "$\neg$" in front of any quantifier is $\boxed{}$.

Ans. $\exists x \forall y[(x \vee y) \wedge \neg z]$

Calculus

1. The equation of the tangent line at the point $(2, 2)$ to the curve $x^3 - 4xy + y^3 = 0$ is $\boxed{}$.

Ans. $y = 4 - x$.

2. A point moves along the curve $y = x^2$ for time $t \in [0, \frac{\pi}{2})$ such that the line joining the point and the origin makes an angle t with the positive x-axis. The position and velocity of the point at time t is $\boxed{}$ and $\boxed{}$.

Ans. Position: $(\tan t, (\tan t)^2)$, Velocity: $\left(\frac{1}{1+t^2}, \frac{2\tan t}{1+t^2}\right)$.

Linear Algebra

1. Let $A = \begin{bmatrix} 1 & 2 & -1 \\ 2 & 1 & 1 \\ 1 & 2 & -1 \end{bmatrix}$ and $b = \begin{bmatrix} 5 \\ 1 \\ 5 \end{bmatrix}$. The solution to the linear system of equations $Ax = b$, if it exists, is $\boxed{}$.

Ans. One solution is $b = [0, 2, -1]^T$.

2. Let $A = \begin{bmatrix} 1 & 1 & 1 \\ 1 & 0 & a \\ 1 & -1 & 0 \end{bmatrix}$. The values of a for which the system of linear equations $Ax = \mathbf{0}$ will have a unique solution are $\boxed{}$.

Ans. $a \neq \frac{1}{2}$.

Probability

1. The sample space corresponding to an experiment of counting the number of voice packets of silence produced by a group of N speakers in a 10 milli sec. period is $\boxed{}$

Ans. $S = 0, 1, 2, ..., N$

2. A shipment of components consists of three identical boxes. One box has 2000 components of which 25% are defective, the second box contains 5000 components of which 20% are defective and the third box has 2000 components of which 600 are defective. A box is selected at random and a component removed at random. The probability that this component is defective is $\boxed{}$. The probability that it was taken out from the second box is $\boxed{}$.

Ans. 0.25 and 4/15

Programming

1. What are the values of `a` and `b` after the following statements execute?

```
int a = 3; b = 4;
int *aptr = &a *bptr = &b;

bptr = aptr;
a = *btpr;
```

`a` is $\boxed{}$ and `b` is $\boxed{}$.

Ans. $a = 3, b = 4$.

2. Consider the incomplete function `powerOf` given below. The call `powerOf(n, x)` should return the quantity $\mathtt{n}^{\mathtt{x}}$.

```
int powerOf(int base, int power)
{
    int result;
    if ([          ])
        result = [          ];
    else
        result = [          ] * powerOf(base, power - 1);
}
```

Ans. *power == 0, result = 1, result = base*

Part II: Computer Science & Engineering

Data Structures and Algorithms

1. An algorithm takes 20 msec for an input size of 1000. If the algorithm has a quadratic growth rate, it would take approximately $\boxed{}$ msec to solve a problem of size 10000.

Ans. 2000.

2. If we add a directed edge to a directed graph with s strongly connected components, the number of strongly connected components in the resulting graph can equal any number between $\boxed{}$ and $\boxed{}$.

Ans. 1 and 5.

Operating Systems

1. Assume three jobs arrive at approximately the same time, but Job A arrives slightly before Job B, and Job B arrives slightly before Job C. Job A takes 2 seconds of CPU, Job B takes 8 seconds, and Job C takes 7 seconds. Assume a time-slice of 1 second. Given a Round-Robin scheduler, the turnaround time of Job B will be ☐ seconds.

Ans. 17

2. Consider the following components of program state: register values, heap memory, global variables, and stack memory. Exactly two of these components are shared across threads in a multi-threaded process. They are ☐ and ☐.

Ans. Global variables, heap memory.

Database Systems

1. Consider the relation R with attributes A, B, C, and D and with the following functional dependencies (FDs): $ABC \rightarrow D$, $A \rightarrow B$. A candidate key of R is $\boxed{}$.

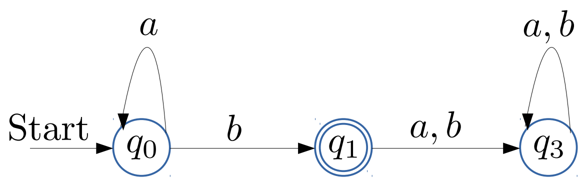
Ans. AC

2. The SQL query `SELECT * FROM R1, R2;` can be expressed as $\boxed{}$ in relational algebra.

Ans. $R1 \times R2$.

Theory of Computation

1. The language accepted by the following automaton is $\boxed{}$.



Ans. $\{a^n b : \; n \geq 0\}$

2. Let $G = (\{S\}, \{a, b\}, P, S)$ be a grammar with productions $S \to aSa, S \to bSb, S \to \lambda$.

   Then the language generated by the above grammar is $\boxed{}$.

Ans. $(0 + 1)^*0(0 + 1)^*$

Computer Networks

1. A particular computer is on an Ethernet LAN and runs TCP/IP. An application on the computer sends some data across the LAN. The first byte in the Ethernet payload field will be the ________ byte of the ________.

Ans. first, IP header

2. Consider the Go-Back-N (GBN) and Selective Repeat (SR) automatic repeat request protocols. Let the window size be W. The sender side of GBN uses ________ timer(s) and the sender side of SR uses ________ timer(s).

Ans. 1, W

Part II: Electronics & Communication Engineering

Electronic Circuits

1. In the circuit shown in Figure 1 below, R_{eq} is $\boxed{}$.

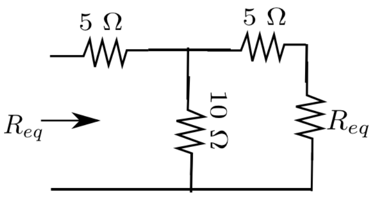


Figure 1:

Ans. 11.18Ω ($\sqrt{125}$Ω).

2. Considering the diodes D_1 and D_2 shown in the circuit in Figure 2 as ideal, and inputs I_1, I_2 are 0 volts for logic 0, and 10 volts for logic 1, the logic gate represented by the circuit is $\boxed{}$.

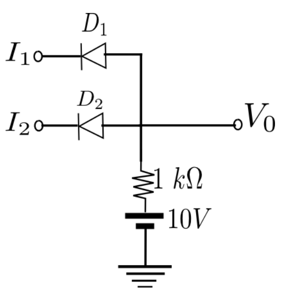


Figure 2:

Ans. AND

Signals & Systems

1. Let u be the discrete unit step signal. The output of a discrete-time LTI system, when the input is u is $y(n) = n \cdot u(n)$. The output of the same system when the input signal is

$$p(n) = \begin{cases} 2, & 0 \leq n \leq 7 \\ 0, & n < 0, n \geq 8 \end{cases}$$

is $\boxed{}$.

Ans. $2[n\ u(n) - (n-8)\ u(n-8)]$

2. Suppose $x(t)$ is a real valued, odd periodic signal with period $T = 2$. It has at most three non-zero Exponential Fourier series coefficients: $\{c_{-1}, c_0, c_1\}$. Moreover the signal energy is given to be 1. The signal $x(t)$ could be $\boxed{}$.

Ans. $\pm \sin(\pi\ t)$

Analog and Digital Communication

1. If $m_h(t)$ is the Hilbert transform of $m(t)$, then the Hilbert transform of $m_h(t)$ is $\boxed{}$.

Ans. $-m(t)$

2. For an additive white Gaussian Noise (AWGN) channel, matched filter maximizes the signal to noise ratio (SNR) at the output of the filter. The SNR at the input of the filter is $\boxed{}$.

Ans. 0.

Digital Signal Processing

1. A signal $x(t) = 2\cos(400\pi t) + 6\cos(640\pi t)$ is ideally sampled at $f_s = 500$ Hz and the sampled signal is passed through an ideal low pass filter with a cutoff frequency of 400 Hz. The frequency components that appear at the output of the filter are (in Hz) $\boxed{}$.

Ans. 180, 200, 300, 320 Hz

2.

3. The frequency response $H(jw)$ of a digital filter is given by $1 + 2\cos w$. It's impulse response is $\boxed{}$.

Ans. $h[n] = 1, -1 \leq n \leq 1$

Section 5: Electromagnetic Theory

1. If E is the electric field intensity and H is the magnetic field intensity, the power flow vector P can be written as ____________.

Ans. $P = E \times H$.

2. If the attenuation of a transmission line is 3 nepers, the attenuation is ____________ dB.

Ans. 26.1