

భారతీయ సాంకేతిక విజ్ఞాన సంస్థ హైదరాబాద్
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Advt. No. IITH/2023/Rec/NF/13
Question Paper ID: 003

Application Number of the Candidate

Name of the Post: **Junior Technician- Electrical Engineering (CSP)**

Pay Level: **03**

Date & Time of the Exam: 25.08.2023 & **09:00 Am** Duration: 01 hr. 30 min

Scheme of the Exam:

Topic	Number of Question	Marks
General English	5	5
Arithmetic	5	5
Communications	10	10
Signal Processing	10	10
Programming	10	10

Instructions to fill the responses in the OMR answer sheet

1. Candidate must write his/her **application number** in the designated box on the top of OMR answer sheet
2. Candidate must write Question paper ID in the designated box on the top of OMR answer sheet
3. Candidate must sign in the box provided in the OMR answer sheet
4. Each answer sheet must be signed by the invigilator in the space printed in the OMR answer sheet
5. Only one response to be selected & marked. In case more than one response is marked for a single question or no response is marked for a question, no marks will be awarded for that question.
6. Partially filled circles shall not be considered as responses
7. Erasing or changing of answer is not allowed.
8. No negative marking
9. Candidate must use Blue/Black ball point pen to fill his/her responses
10. Rough work should not be done on the OMR answer sheet.
11. Candidate can use the designated page(s) of the question booklet for the purpose of rough work

Question Paper

40 points

Note: Each question carries 1 point. There is no negative marking. Applicants are encouraged to attempt all questions.

1 GENERAL ENGLISH (5 POINTS)

In some of the questions in this section you are required to fill two or more blanks using the correct option (the order of the answers in each option is same as the order of the blanks).

- 1) Choose the most appropriate response to this statement: "I do not understand the description of this algorithm."
 - a) Would you like my help?
 - b) I think you can.
 - c) The textbook contains a new problem.
 - d) I didn't do anything in particular.
- 2) Fill the blank: The knowledge of the student was _____ poor that he could not pass the examination.
 - a) and
 - b) such
 - c) so
 - d) whether
- 3) Fill the blank: The tutor began the lecture _____ her most interesting example.
 - a) in
 - b) also
 - c) along
 - d) with
- 4) Fill the blank: It was only last week _____ we started playing badminton.
 - a) after
 - b) later
 - c) sooner
 - d) that
- 5) Fill the blank: The laboratory is somewhere in the _____ of the sports complex.
 - a) region
 - b) bus stop
 - c) closeby
 - d) vicinity

2 ARITHMETIC (5 POINTS)

- 6) Identify the next number in the following sequence
1, -3, 9, -27, 81
 - a) 127
 - b) -127
 - c) 243
 - d) -243
- 7) What is the value of $\log_2(2400)$ if the value of $\log_2 3 = 1.58$ and $\log_2 10 = 3.32$?
 - a) 7.9
 - b) 11.22
 - c) 16.22
 - d) 10.9
- 8) There are 4 black balls, 6 white balls and 10 red balls in a basket. Three balls are picked from the basket. In how many ways can we choose the 3 balls so that all three balls have different colors?
 - a) 6840
 - b) 1140
 - c) 240
 - d) 20
- 9) Consider two spheres, where the radius of the first sphere is twice the radius of the second sphere. What is the ratio of the volume of the first sphere to the volume of the second sphere?
 - a) 8
 - b) 4
 - c) 2
 - d) 1/4
- 10) The following system of linear equations

$$6x + 11y = 32, \quad 2x + 22y = 7$$
 has
 - a) no solution
 - b) exactly one solution
 - c) exactly two solutions
 - d) infinitely many solutions

3 COMMUNICATIONS (10 POINTS)

- 11) Suppose we toss a fair coin 10 times, and record their outcomes as a sequence of 10 values (head (H) or tail (T)). What is the probability that the first and last values of this sequence are same?

a) 1/1024
 b) 1/256
 c) 1/4
 d) 1/2

- 12) A real number x is quantized to an integer $Q(x)$ as follows

$$Q(x) = \min \{ \max \{ \text{round}(x), 3 \}, 10 \}$$

where the function $\text{round}(\cdot)$ provides the nearest integer to a given input. How many possible values can $Q(x)$ take?

a) 4
 b) 7
 c) 8
 d) 10

- 13) If X is an exponential random variable with mean 1, what is the probability of the event $X > 1$?

a) $1/e$
 b) $1/2e$
 c) $1/e^3$
 d) $1/2e^3$

- 14) A sinusoidal signal of power 40dBm is passed through an amplifier with power gain 5dB. What is the power at the output of the amplifier?

a) 200dBm
 b) 45dBm
 c) 200dB
 d) 45dB

- 15) A printer is connected to a computer via a digital link with data rate 1 Mbps. A text file with 500 characters is to be communicated from the computer to the printer, where each character is encoded using 8-bit ASCII code. What is the time duration required for this communication?

a) $500\mu\text{s}$
 b) 4ms
 c) 500ms
 d) 5ms

- 16) For the 64-QAM modulation scheme, find the

number of points in the constellation diagram that have exactly 2 nearest neighbors.

a) 36
 b) 60
 c) 16
 d) 4

- 17) Suppose a BPSK signal space constellation $\{+1, -1\}$ is used in an AWGN channel with noise variance $N_0/2$. If the point -1 is transmitted, what is the probability that the optimal demodulator makes as mistake?

a) $2Q\left(\sqrt{\frac{2}{N_0}}\right)$
 b) $2Q\left(\sqrt{\frac{8}{N_0}}\right)$
 c) $Q\left(\sqrt{\frac{2}{N_0}}\right)$
 d) $Q\left(\sqrt{\frac{8}{N_0}}\right)$

- 18) Which of the following modulation schemes can be demodulated non-coherently?

a) 16-QAM
 b) 8-PSK
 c) differential PSK
 d) FM

- 19) If we double the symbol duration and double the carrier amplitude of BPSK modulation, then

a) the signal power increases by a factor of 2
 b) the energy per bit remains the same
 c) the bandwidth reduces by a factor of 2
 d) the bit error rate increases

- 20) Which of the following technologies is NOT present in the 4G cellular standards?

a) OFDM
 b) MIMO
 c) Channel Coding
 d) CDMA

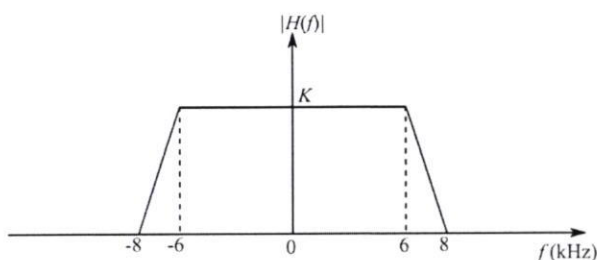


Fig. 21.

4 SIGNAL PROCESSING (10 POINTS)

- 21) A band limited low pass signal $x(t)$ of bandwidth 5 kHz is sampled at sampling rate f_s . The signal $x(t)$ is reconstructed using the reconstruction filter $H(f)$ whose magnitude response is shown in Fig. 21. The minimum sampling rate f_s in (kHz) for perfect reconstruction of $x(t)$ is
- 5
 - 10
 - 15
 - 20

- 22) The input $x(t)$ and the output $y(t)$ of continuous time system are related as

$$y(t) = \int_{t-T}^t x(u) du \quad (22.1)$$

The system is

- linear and time-invariant
 - linear and time-variant
 - nonlinear and time-invariant
 - nonlinear and time-variant
- 23) The autocorrelation function $R_X(t)$ of a wide sense stationary random process $X(t)$ is shown in Fig. 23. The average power of $X(t)$ is
- 2
 - 1
 - 0
 - 2
- 24) $x(-t) * \delta(-t - t_0) =$
- $x(t + t_0)$
 - $x(t - t_0)$
 - $x(-t + t_0)$
 - $x(-t - t_0)$
- 25) The period of the signal $x(t)$ in Fig. 25 is
- 1
 - 2

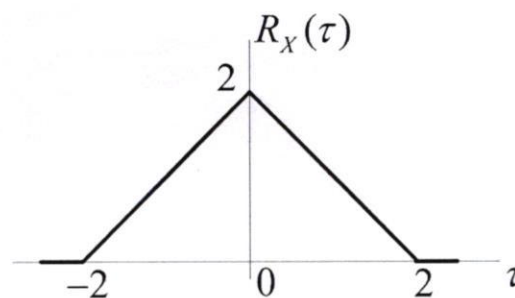


Fig. 23.

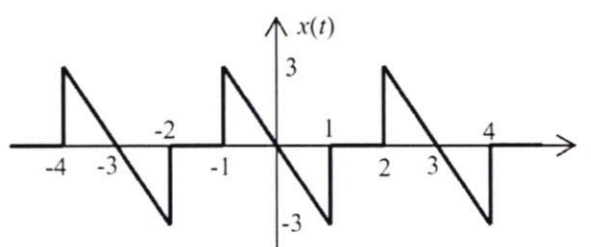


Fig. 25.

- 3
 - 4
- 26) Consider $x(t)$ as given in Fig. 25. The value of

$$\int_0^3 x(t) dt$$

is equal to

- 3
 - 3/2
 - $\sqrt{2}$
 - None of the above
- 27) Consider $x(t)$ as given in Fig. 25. Let

$$y(t) = \begin{cases} 1 & \text{if } x(t) > 0 \\ 0 & \text{if } x(t) \leq 0 \end{cases}$$

Then, $y(t)$ is a

- sawtooth wave
- rectangular wave
- sine wave
- none of the above

- 28) Consider $y(t)$ as in the previous problem. The value of

$$\int_0^3 y(t)dt$$

is equal to

- a) 0
b) 1
c) 2
d) 3
- 29) The value of p such that the vector $\begin{pmatrix} 1 \\ 2 \\ 3 \end{pmatrix}$ is an eigenvector of the matrix

$$\begin{pmatrix} 4 & 1 & 2 \\ p & 2 & 1 \\ 14 & -4 & 10 \end{pmatrix}$$

is

- a) 15
b) 16
c) 17
d) 18
- 30) The impulse response of a continuous time system is given by $h(t) = \delta(t-1) + \delta(t-3)$. The value of the step response at $t = 2$ is
- a) 0
b) 1
c) 2
d) 3

5 PROGRAMMING (10 POINTS)

- 31) The output of the program

```
#include <stdio.h>

int main()
{
    double a = 2.0, b = 0, c = 2.0;
    if (b*b - 4*a*c = 0)
    {
        printf("Equal_roots\n");
    }
    else
    {
        printf("Unequal_roots\n");
    }
    return 0;
}
```

is

- a) Equal Roots
b) Unequal Roots
c) Compilation Error
d) None of the above

```
#include <stdio.h>

int myfunc(int x, int y)
{
    if(x/y>0)
        printf("%d,",x);
    else
        printf("%d,",y);
    return 0;
}

int main()
{
    int a = 3, b = -4, c = -2;
    myfunc(b,a);
    myfunc(a,c);
    return 0;
}
```

Problems 32- 33 are based on the above code.

- 32) The output of the program is
- a) compilation error
b) 3, -2,
c) 1, -2,
d) 1, 3,
- 33) For $b = -4$, the output of the program is
- a) compilation error
b) -4, -2,
c) 3, 3,
d) none of the above

Problems 34 - 38 are based on the following code

```
#include <stdio.h>

long int f(int m,int n)
{
    if (n > 0)
    {
        return m*f(m,n-1);
    }
    else
        return 1;
}

int main()
{
    int m = 12, n = 2, x, d = 10;

    x = f(m,n);

    printf("%d, %d, %ld, %ld, %ld", m,n,x, x/d, x
        %d );

    return 0;
}
```

- 34) $x =$
- 12
 - 24
 - 144
 - Compilation Error
- 35) $f(m, n) =$
- m^n
 - $m + n$
 - mn
 - Compilation Error
- 36) $x/d =$
- 14
 - 15
 - 16
 - 17
- 37) $x\%d =$
- 2

- 3
- 4
- 5

38) The given code is an example of

- subversion
- inversion
- conversion
- recursion

Problems 39- 40 are based on the following code

```
#include <stdio.h>

int main()
{
    int x = 3, y = 4;
    int z, w;

    z = (x << 2)/4;
    w = (y * 4)>>2;
    printf("%d_%d", z, w);
    w = (y>>1)% x;
    printf("%d\n", w);

    return(0);
}
```

39) The output of this program is

- 0 0 0
- 3 4 5
- 3 4 2
- compilation error

40) Suppose that the first line within main() is replaced with `int x = 4, y = 5;`
The output would be

- compilation error
- 3 4 5
- 4 5 2
- none of the above