

請在答案卷上標記**Part**與題號，可不依序作答。順序上建議挑選自己專長優先作答

C

1. `int A[10]` is a sorted array. Write a function to implement the binary search to search a specified integer.
2. Write the output of this program.

```
#include <stdio.h>
int foo(int v)
{
    v = 20;
}

int main(void)
{
    int a[5] = { 1, 2, 3, 4, 5 };
    int *ptr = (int*)&a + 1;

    printf("%d %d\n", *(a + 1), *(ptr - 1));

    int v = 10;
    foo(v);
    printf("v = %d\n", v);

    return 0;
}
```

3. Write a function to calculate the *great common divisor* of any two positive integers.
- 4.

```
int f(int n)
{
    if (n <= 2)
        return 1;

    return f(n - 1) + f(n - 2);
}
```

Calculate the time complexity. Improve the function `f` and calculate the time complexity again.

5 . Explain these two keywords (C language) - `volatile` and `static` .

6 . `a` is a variable with type `uint32_t` . Change the bits of this index range `[4:7]` (bit-index counted from 0 to 31) to `0xa` and preserve the other bits. For example, if `a = 0xbbccbacc` , `a` will be changed into `0xbbccbbaa` .

Write the result into the address - `0x70001234` .

7 . Write a function to detect the endianness for your platform.

Math

1 . Define $f : \mathbb{R}^3 \rightarrow \mathbb{R}$ by

$$f(x, y, z) = 2^x + x \exp(y) + \ln(z).$$

Calculate ∇f .

2 . Write the Taylor series for $\exp(x)$ and $\ln(1 - x)$ at $x = 0$.

3 . Let $P_1 = (-1, -14)$, $P_2 = (0, -10)$, $P_3 = (1, -6)$, $P_4 = (2, 4)$. Then $\{P_i\}_{i=1}^4$ is a subset of \mathbb{R}^2 . Find a polynomial f of degree 3 such that $f(x_i) = y_i$ with $P_i = (x_i, y_i)$ for $i = 1 \dots 4$.

4 . Use the Newton method to approximate the real root of $f(x) = x^3 - a$ for $a \geq 0$.

5 . Let $A = \{(x_i, y_i)\}_{i=1}^N$. Then A is a subset of \mathbb{R}^2 . Find the regression line by using the method of least square.

6 . Define $f : \mathbb{R}^3 \rightarrow \mathbb{R}^2$ by

$$f(x, y, z) = (x + y, y + z).$$

Write the Jacobian matrix of f .

7 .

$$A = \begin{bmatrix} 1 & 1 \\ 1 & 0 \end{bmatrix}$$

Calculate the eigenvalues of the matrix A .

Digital Signal Processing

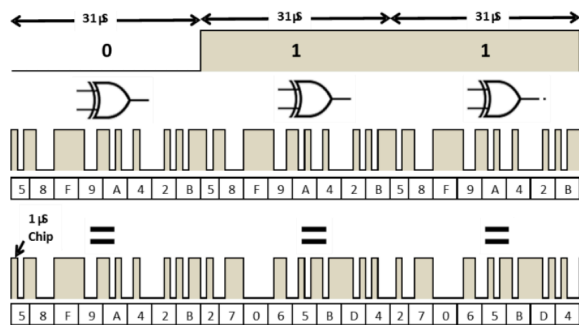
1 . Explain the transform relationship about periodic and sampling signals on the time domain and

frequency domain by : Fourier transform(FT), Fourier series(FS), discrete-time Fourier transform(DTFT), and discrete Fourier transform(DFT).

2 . Assume a N-points moving average filter has the form $y[n] = \frac{1}{N} \sum_{k=0}^{N-1} x[n - k]$. What is the filter frequency response $H(e^{j\omega})$? Sketch the amplitude frequency response of the filter with respect to ω and indicate what kind of filter type does it look like?

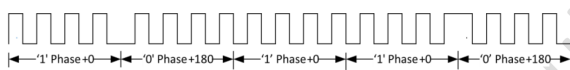
3 . An A/D convertor includes an uniform quantizer which transform the sampling analog signal with range $I \equiv [-m, m]$ into R -bits quantization level. If the input signal's power is P and the quantization error is uniform distribution, calculate the signal to quantization noise ratio $(SNR)_Q$ in dB.

4 . Assume a DSSS modulation system is encoded by the 31-bits PN code as the following picture.



What is the auto-correlation function $R_\tau(t)$ of the system? What is the DSSS system interference immunity $(SNR)_O/(SNR)_I$? ($(SNR)_I$: before encoding, $(SNR)_O$: after encoding)

5 . A D-BPSK encode uses the 180 degree phase shift from the previous phase when sending bit is '0' as the follow.



Write the encode relationship between the input bit b_k and the output bit d_k to control the pulse train generator.