

Technical Questions on C and Embedded Systems 😊

Q1. Difference between C and Embedded C ?

⇒ C Programming :

- Used for general purpose applications, OS development, and software tools.
- Uses standard libraries (stdio.h, stdlib.h, etc).
- High portability across different hardware platforms.
- No direct access to hardware registers.

Embedded C :

- Designed for microcontrollers and embedded systems.
- Directly interacts with hardware (eg., controlling GPIO, UART, I2C).
- Uses memory-mapped registers instead of standard libraries.
- Optimized for power efficiency and real-time constraints.

Example Code Comparison :-

• C Program (Standard Output) :

```
#include <stdio.h>
int main () {
    printf ("Hello, World! \n");
    return 0;
}
```

• Embedded C Program (Microcontroller LED ON/OFF) :-

```
#include <avr/io.h>
int main () {
    DDRB |= (1 << PB0); // Set PB0 as output
    PORTB |= (1 << PB0); // Turn ON LED
    while (1);
    return 0;
}
```


Q2. Volatile vs Const in Embedded Systems .

⇒ Volatile :-

- Tells the compiler not to optimize the variable .
- Used when a variable's value can change unexpectedly (e.g., hardware registers, interrupt flags) .
- Example : Reading a sensor value that may change at any time) .

```
volatile int sensor_value ;  
void read_sensor () {  
    sensor_value = *(volatile int *) 0x40020000 ;  
}
```

↑↑
Read sensor data

Const :

- Declares a read-only variables whose value cannot change .
- Used for defining fixed values like baud rate , PI etc .
- Examples :

```
const int BAUD-RATE = 9600 ; // Fixed UART baud  
                             rate
```

Key Difference :-

- volatile prevents unwanted optimizations .
- const ensures a variable remains unmodifiable .

Q3. Pointers in Embedded Systems .

⇒ Definition :- A pointer is a variable that stores the memory address of another variable .

Uses in Embedded Systems :-

- Accessing hardware registers .
- Implementing efficient memory management .
- Using function pointers for callback mechanisms .

Example : Direct register Access using Pointers :

```
#define GPIO_PORT *((volatile unsigned int *) 0x40020C00)
void main() {
    GPIO_PORT = 0xFF ; // Turn ON all GPIO pins
}
```

↑↑
Register Address

Function Pointers in Embedded Systems :-

- Used for ISR (Interrupt Service Routine) handlers.

- Example :

```
void (*reset_func)(void) = (void (*)(void)) 0x00000000 ;
reset_func() ; // jump to reset address
```

↑↑
Assign reset vector

Q4. Stack vs Heap in Embedded Systems .

⇒ Stack :

- Stores local variables and function call information.
- Memory allocation is automatic (allocated and deallocated by function calls).
- Fast access, but has a limited size.

Example :-

```
int a = 10 ; // stored in stack
```

Heap :

- Stores dynamically allocated memory.
- Memory allocation is manual (needs malloc() and free()).
- More flexible but slower than stack.

Example :-

```
int *ptr = (int *) malloc (sizeof(int)) ;
free(ptr) ;
```

↑↑
Allocated in Heap

↑↑
Prevent memory leak .

Issue in Embedded Systems :-

- Stack overflow occurs when recursion is used without a base condition.

Example of stack overflow issue :-

```
void recursive_function () {  
    recursive_function (); // no base case = stack  
                            overflow !  
}
```

Q5. UART, SPI and I2C in Embedded Systems.

⇒ UART (Universal Asynchronous Receiver-Transmitter) :-

- Asynchronous serial communication (no clock signal).
- Uses TX (Transmit) and RX (Receive) lines.
- Common baud rates : 9600, 115200 bps.

Example :-

```
UART_Write ('A'); // sends character 'A'
```

SPI (Serial Peripheral Interface) :-

- Synchronous serial communication (uses a clock signal).
- Uses 4 wires : MISO, MOBI, SCK, SS.
- Used in SD cards, sensors, and flash memory.

Example :-

```
SPI_Write (0xAA); // Sending data to SPI device
```

I2C (Inter-Integrated Circuit) :-

- Uses only 2 wires : SDA (Data) and SCL (Clock).
- Supports multiple slave devices.
- Used in temperature sensors, EEPROMs, and RTCs.

Example :-

```
I2C_Start ();
```

```
I2C_Write (0x50); // send device address
```


Q6. CAN Protocol in Automotive ?

⇒ A message based protocol used in automotive and industrial applications.

- Supports multi-master communication.
- Provides error detection and fault tolerance.

Features :-

- Priority-based arbitration (higher priority messages get access first).
- Supports multiple nodes on a single bus.
- Real-time performance (fast response in vehicle control systems)

Example :- CAN message Transmission in C :-

CAN_Transmit (messageID, data, length);

Q7. RTOS vs General OS :-

⇒ RTOS (Real-Time Operating System) :

- Used in automotive ECUs, industrial automation, and medical devices.
- Provides deterministic task scheduling (guaranteed execution time).
- Low latency for real-time applications.

Examples RTOS task creation :-

XTaskCreate (Task1, "Task1", 100, NULL, 1, NULL);

General OS (Windows, Linux, etc) :-

- Used for general computing tasks.
- Non-deterministic scheduling (task execution order is unpredictable).
- Designed for user applications like web-browsing, gaming and office work.

Q8. Debugging tools in Embedded Systems .

⇒ GDB (GNU Debugger) :- Used for debugging C programs in Linux .

- CANoe :- Used for testing and debugging CAN protocol based application .
- SonarQube :- Used for code quality analysis and bug detection .

Q9. Code optimization in Embedded Systems :-

⇒ Use Bitwise Operation instead of Arithmetic :

```
#define SET_BIT (PORT, BIT) (PORT |= (1 << BIT))
```



Faster than arithmetic

- Reduce function calls and loops to save execution time .
- Use static, const to optimize memory usage .
- Enable Compiler optimization flags (-O2, -O3) .

Final Thoughts :- These are the technical concepts you must master before your Embedded Developer or C Developer interview .

Q10. Difference between macro and inline function ?

⇒ Features

- 1) Definition
- 2) Type Safety
- 3) Debugging
- 4) Performance

Macros

```
#define SQUARE(x) (x * x)
```

No type checking .

Hard to debug .

Faster (avoids function call overhead) .

Inline function

```
static inline int  
square(int x) {  
    return x * x ;  
}
```

Type-safe .

Easier to debug .

Slightly slower but safer .

General Interview Questions for Embedded Dev 😊

Q1. Tell me about yourself.

⇒ I am an Electronics and Communication Engineer specializing in Embedded Systems, with expertise in C, C++, Embedded C, and Linux OS. I have hands-on experience in firmware deployment, debugging, and working with communication protocols like UART, SPI, CAN and I2C. In my role at current organization, I contributed to developing camera communication modules, reducing latency, and optimizing embedded systems. I have also worked on AI/ML integration, annotation tools and vision deployment. I am passionate about solving complex technical challenges and developing optimized Embedded Solutions.

Q2. Why do you want to switch jobs?

⇒ I am looking for a new opportunity where I can further enhance my Embedded Systems skills, take on more challenging projects, and contribute to innovative solutions. While I have gained valuable experience in my current role, I believe that this opportunity will allow me to grow both technically and professionally.

Q3. What are your strengths and weaknesses?

⇒ Strengths:

- Strong programming skills in C and Embedded C.
- Experience with Linux OS and firmware deployment.
- Knowledge of communication protocols (UART, SPI, CAN).
- Quick problem-solving and debugging skills.
- Experience working in automotive and embedded domain.

Weakness:

- Sometimes I get too focused on optimizing code and spend extra time on minor improvements. However, I have learned to balance optimization with deadlines.

Q4. What do you know about our company ?

⇒ Research the company's products, services, and recent projects before the interview. Mention any embedded projects they are working on, and how your skills align with their requirement.

HAPPY LEARNING 😊