**­­C++ Interview questions**

1. C++ Core concepts
   1. Constructor and destructors
   2. Operator overloading and function overloading
   3. Virtual class and friend class
   4. Polymorphism
   5. Virtual functions
   6. Virtual destructors
   7. Abstract classes
   8. File operations
   9. Constant, mutable
   10. Templates
   11. RTTI
2. STL
   1. Vector
   2. List
   3. Map
   4. Hash table
   5. unordered\_map, unordered\_set
3. Class diagram for your project
4. Design Patterns, Provide use cases
   1. Creational
      1. Singleton design pattern
      2. Abstract factory
   2. Structural
      1. Proxy and Adaptor
      2. Composite
   3. Behavioral
      1. Observer
      2. visitor
5. Multi-threading
   1. Semaphore
   2. Mutex

**Mutex**: Mutual exclusion, for synchronization of two processes, any of this two process can have KEY (MUTEX) to proceed there work, implemented as locking mechanism.

**Semaphore**: Generalization of mutex, implemented as signaling mechanism

**Binary semaphore**:

**Main Difference between mutex and semaphore**

Mutex is Locking Mechanism.

Semaphore is Signaling mechanism.

**Recursive and Non recursive mutex:**

**Shared Mutex**

**Read/Write mutex**

**Spin locks**

**C++ Mutex types**

1. **std::mutex**
2. **std::timed\_mutex**
3. **std::recursive\_mutex**
4. **std::recursive\_timed\_mutex**
5. **std::shared\_timed\_mutex**

**C++ Lock types**

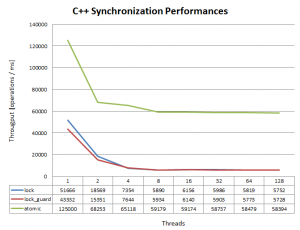
1. **std::lock\_guard<>**
2. **std::unique\_lock<>**
3. **std::shared\_lock<>**

**Performance comparisons**

A single std::mutex with calls to lock() and unlock()

A single std::mutex locked with std::lock\_guard

An atomic reference on the integer



Ref : <http://baptiste-wicht.com/posts/2012/04/c11-concurrency-tutorial-advanced-locking-and-condition-variables.html>

C++ /OOPs interview Questions

1. What is OOP?

* Philosophy of design and implementation, which is based on concept of object and classes.
* Programming language Model, organized around object
* Historically programming has been viewed as logical procedure
* It is not procedural programming.

1. What are building blocks of OOP?
   1. Classes and objects
   2. Encapsulation
   3. Data Abstraction
   4. Inheritance
   5. Polymorphism
2. Explain classes and objects in details.
   1. Concept

* The fundamental building of OO software.
* It is just a blueprint
* Object is a region of storage associated with class.
* Defines basic characteristics and behaviors of similar kind of data.
  1. Give one/two theoretical example (simple bookish example)
  2. Give one/two classical example (Practical / real example)
  3. Give one/two example from your project (Actual example on which you worked)

1. Explain Encapsulation in details.
   1. Concept

* Data hiding
  1. Give one/two theoretical example (simple bookish example)
  2. Give one/two classical example (Practical / real example)
  3. Give one/two example from your project (Actual example on which you worked)

1. Explain abstraction in details.
   1. Concept

* Exposing only essential details and hiding other irrelevant details.
* Reduces code complexity
  1. Give one/two theoretical example (simple bookish example)
  2. Give one/two classical example (Practical / real example)
  3. Give one/two example from your project (Actual example on which you worked)

1. Explain Inheritance in details.
   1. Concept

* Derive new type of objects from existing objects.
  1. Give one/two theoretical example (simple bookish example)
  2. Give one/two classical example (Practical / real example)
  3. Give one/two example from your project (Actual example on which you worked)

1. Explain polymorphism in details.
   1. Concept
   2. Give one/two theoretical example (simple bookish example)
   3. Give one/two classical example (Practical / real example)
   4. Give one/two example from your project (Actual example on which you worked)
2. What is mean by Generalization?
   1. Concept
   2. Give one/two theoretical example (simple bookish example)
   3. Give one/two classical example (Practical / real example)
   4. Give one/two example from your project (Actual example on which you worked)
3. What is mean by Specialization?
   1. Concept
   2. Give one/two theoretical example (simple bookish example)
   3. Give one/two classical example (Practical / real example)
   4. Give one/two example from your project (Actual example on which you worked)
4. What is mean by Composition?
   1. Concept
   2. Give one/two theoretical example (simple bookish example)
   3. Give one/two classical example (Practical / real example)
   4. Give one/two example from your project (Actual example on which you worked)
5. What is mean by Association?
   1. Concept
   2. Give one/two theoretical example (simple bookish example)
   3. Give one/two classical example (Practical / real example)
   4. Give one/two example from your project (Actual example on which you worked)
6. What is mean by Aggregation?
   1. Concept
   2. Give one/two theoretical example (simple bookish example)
   3. Give one/two classical example (Practical / real example)
   4. Give one/two example from your project (Actual example on which you worked)
7. What are types of inheritance? Give practical example of each type.
8. What are types of polymorphism? Give practical example of each type.
9. What is copy constructor and copy assignment operator?
10. What is mean by shallow copy and deep copy? When to use which copy?
11. What are destructors? Why we need to use virtual destructor?
    1. Case when you have multiple inheritance
    2. Case when you multilevel inheritance
    3. Case when you have hybrid inheritance
    4. So each all above cases, which call destructors, you will define virtual?
12. What are pointers, what are references?
13. Explain following concepts along with example.
    1. Smart pointers
    2. Unique pointers
    3. Shared pointers
    4. Auto pointers
    5. Dangling pointers
    6. Void pointer in C vs void pointer in C++
14. Difference between malloc and new, free and delete, with example.
15. Allocate memory for 1d array, 2d array using new operator.
16. What is stack memory and heap memory?
17. What is stack unwinding?
18. Operator overloading examples
    1. Pre increment and post increment overloading
    2. New/delete operator overloading
    3. Operator overloading with help of friend functions.
    4. Conversion operator
    5. Conversion constructor
19. What are namespaces? What is koening lookup? How it is useful?
20. What are exception? How to handle exceptions? Have you used them any of your programs? Please explain with examples
21. What are templates?
    1. What are function templates
    2. What are class templates
    3. Write a program for class template
    4. Write a program for function template.
22. What are all string operations?
    1. Strrev
    2. Strcpy
    3. Strstr
    4. Substr
23. What is RTII?
24. Explain each cast.
25. What is RAII?

Multithreading and Multi Processing and OS Concepts.

1. What is process?

* It is an instance of program in execution. It has following major sections
* Data: Global and static variables, allocated and initialized prior execution of program.
* Text or Code: Compiled code, instructions or op-codes.
* BSS section: Uninitialized variables.
* Stack: local variables, function calls context.
* Heap: dynamic memory allocation, new, malloc, free delete etc.
* Process control block: contains information about each process.
* A process is just container for its threads.

1. What is thread?

* A basic unit of CPU utilization
* A light weight process.
* Multithreaded application have multiple threads within single process, each having their own program counter, stack and set of registers, but sharing common code, data and certain structures such as open files.
* All threads within a process share same address space and OS resources.

1. What is process control block? What are elements of process control block?

* Program counter and value of all program registers.
* Memory management information
* Accounting information such as time used, ID
* I/O status : list of open files, devices
* Scheduling data : priority
* Process state: New, ready, running, waiting, suspended, terminated.
* Linux PCB (task\_struct) has 106 fields.

1. What is thread control block? What are elements of thread control block?

* Program counter
* Registers.
* Linux TCB (thread\_struct) has 24 fields.
* A pointer to parent process.

1. What are different process states?

* In 5 state process model, following are the states
  + New
  + Running
  + Ready
  + Waiting
  + Terminated

1. What are similarities and differences between process and thread?

* Similarities
  + Both share CPU, only one thread active at a time.
  + Both can create child.
  + If one is block another can run.
* Differences
  + Threads are not independent of one another
  + All thread can access any address within task.
  + Threads are designed to assist one another.
  + Thread cannot have independent existence.

1. How to create Process in C program?

* Following are the ways to create new process in Linux.
  + fork:
  + clone:
  + popen:
  + system:
  + execve:
  + pipe:

1. How to create thread in C program?

* pthread\_create()

1. What is Zombie process? How to create zombie process? How to control it?

* A zombie or defunct process is a process that has completed execution but still has an entry in process table.
* This entry is still needed to allow the parent process to read its child’s exit status.
* Kill command has no effect on zombie process.
* When a process ends, all of the memory and resources associated with it are deallocated so they can be used by other processes. However, the process's entry in the process table remains. The parent can read the child's exit status by executing the wait system call, whereupon the zombie is removed.
* Parent process need to use wait call, or SIGCHLD, to get notification for child.

1. What is Orphan process? How to create orphan process? How to control it?

* An orphan process is a computer process whose parent process has finished or terminated, though it is running itself.
* It will be adopted by init system process. The reparenting operation occurs automatically.
* It can be intentionally or unintentionally.

1. What is Daemon process? How to create daemon process? How to control it?

* Daemon is orphan process created intentionally.
* It runs in background, it not in direct control of user interaction.
* In Linux, typically daemon names ends with d e.g. sshd, syslogd etc.

1. What are different segment?

* Text/Code/Instruction segments: It is read only, and initialized from program executable file.
* User data segment
  + Initialized data – string initialized from program executable.
  + Uninitialized data – global variables, these are set to 0
  + Malloc area or heap – Created by process
  + Stack – Auto variables, function parameters
* System data segment
  + Open file descriptors

1. What is BSS segment?

* It is **B**lock **S**tarted by **S**ymbol segment
* Uninitialized global and static variables.

1. In which segment Global variable stored?

* If global variable is initialized, it will be stored in initialized data section.
* If global variable is uninitialized, it will be stored in BSS segment.

1. In which segment dynamically allocated memory is stored?

* Dynamically allocated memory is stored in heap section.

1. What is Re-entrant code? What is thread-safe code? What are similarity and difference between re-entrant code and thread-safe code?

* In single threaded processes, only one flow of control exists, the code executed by these processes thus need not be re-entrant or thread-safe. In multithreaded programs, the same functions and the same resources may be accessed concurrently by several flows of control.
* To protect resource integrity, code written for multithreaded programs must be re-entrant and thread-safe.
* Re-entrant and thread safety are both related to the way that functions handle resources.
* Re-entrant and thread-safety are separate concepts
* A function can be either re-entrant, thread-safe, both or neither.
  + Re-entrant functions
    - Does not hold static data over successive calls, nor it returns pointers to static data.
    - All data is provided by caller function
    - A re-entrant function must not call non re-entrant functions.
  + Thread Safety
    - A thread safe function protects shared resources from concurrent access by locks.
    - Thread safety concerns only the implementation of a function and does not affect its external interface.
    - Any function that does not use static data or other shared resources is trivially thread safe.
    - Use of global data is thread unsafe.
    - Global data should be maintained per thread or encapsulated, so that its access can be serialized.
  + Converting non reentrant function to re-entrant
    - In many cases, non-reentrant function must be replaced with a modified interface to be re-entrant
    - Non-reentrant function cannot be used by multiple threads.
    - So, non-reentrant functions are impossible to be thread safe.
  + Making a function thread safe
    - Making a function re –entrant also makes them thread safe.
    - Locking shared resources
      * Functions that use static data or any other shared resources such as files or terminals must serialize the access to these resources by locks in order to be thread safe.

1. What is difference between logical and physical address space?

* An address generated by CPU is logical address or virtual address.
* Address actually available on memory unit is physical address.
* Virtual and physical address are same in compile time and load time address binding.
* Virtual and physical address differs in execution time address binding schemes.
* The set of all logical address generated by program is referred as logical address space.
* The set of all physical address corresponding to logical address is referred as physical address space.
* Run time mapping from virtual to physical address and vice versa is done by Memory Management unit (MMU).

1. What is swapping?

* Swapping is a mechanism in which a process can be swapped temporarily out of main memory to a backing store and then brought into memory for continued execution.

1. What is fragmentation?

* As processes are loaded and removed from memory, free memory space is broken into little pieces. It happens after some time that processes cannot be allocated to memory blocks considering their small size and memory blocks remained unused. This problem is known as fragmentation.

1. What is external fragmentation?

* Total memory space is enough to satisfy a request or to reside a process in it, but it is not contiguous so it cannot be used. This is called as external fragmentation.

1. What is internal fragmentation?

* Memory blocks assigned to process are bigger. Some portion of memory is left unused as it cannot be used by other process.

1. What is paging?

* External fragmentation is avoided by using paging techniques.
* A paging is techniques in which physical memory is broken into blocks of same sizes called as pages. When a process is to be executed, its corresponding pages are loaded into available memory frames.

1. What is page thrashing?

* When a page is not required in main memory, it would be moved out of main memory, this is called page thrashing.

1. What are interrupts?

* Interrupts alters programs flow of control
* Behavior is similar to a procedure call.
* Interrupts causes transfer of control to an interrupt service routine.
* When ISR is completed, the original program resumes execution.

1. What is Deadlock?

* A set of processes each holding a resource and waiting to acquire a resource held by another process in set.
* A set of processes have a deadlock if each process is waiting for an event that only another process in the set can cause.
* Each process needing what another process has.

1. What are necessary conditions for deadlock?

* A deadlock can occur if following four conditions hold simultaneously
  1. Mutual exclusion: Only one process at a time can use a resource.
  2. Hold and wait: A process holding at least one resource is waiting to acquire additional resources held by other processes.
  3. No preemption: A resource can be released only voluntarily by the process holding it, after that process has completed its task.
  4. Circular wait: there exists a set {P0, P1, …, P0} of waiting processes such that P0 is waiting for a resource that is held by P1, P1 is waiting for a resource that is held by " !P2, …, Pn–1 is waiting for a resource that is held by Pn, and P0 is waiting for a resource that is held by P0."

1. What are measures of deadlock prevention?
2. What are measures of deadlock avoidance?
3. What are measures of deadlock detection?
4. What are measures of deadlock Recovery?
5. What is starvation?
6. How you will decide, whether to use multithreading or multiprocessing for a program?

* Whenever a process has multiple tasks to perform independently of others, go for multithreaded application.
* When in program, if one task is blocked, other tasks need to proceed without blocking, go for multi-threaded application.

1. Provide advantages and disadvantages of multi-threading and multiprocessing.

* ADVANTAGES OF MULTITHREADING
  + **Responsiveness** - One thread may provide rapid response while other threads are blocked or slowed down doing intensive calculations.
  + **Resource sharing** - By default threads share common code, data, and other resources, which allows multiple tasks to be performed simultaneously in a single address space.
  + **Economy** - Creating and managing threads (and context switches between them) is much faster than performing the same tasks for processes.
  + **Utilization of multiprocessor architectures** - A single threaded process can only run on one CPU, no matter how many may be available, whereas the execution of a multi-threaded application may be split amongst available processors.

1. What are different inter process communication mechanisms?

* File: A record stored on disk, or a record synthesized on demand by file server, which can be accessed by multiple processes.
* Signals: A system message sent from one process to another, not usually used to transfer data but instead used to remotely command the partnered process.
* Pipes: A two way data stream between two processes interfaced through standard input and output and read one character at a time.
* Named pipes: A pipe implemented through a file on system instead of standard input and output. Multiple processes can read and write to a file as a buffer for IPC data.
* Sockets: A data stream sent over a network interface, either to a different process on same or different computer in network.
* System V IPC Mechanisms
  + Message Queue: An anonymous data stream similar to socket usually implemented by operating system that allows multiple process to read and write to the message queue without being directly connected to each other.
  + Semaphores: A simple structure that synchronizes multiple processes acting on shared resources.
  + Shared Memory: Multiple processes are given access to same block of memory which creates a shared buffer for the process to communicate with each other.

1. What different types are of inter process communication?

* Message Passing: Allows multiple programs to communicate using channels, commonly used in concurrency models
  + Mailbox
  + Message queue
  + Socket
  + Streams
  + Pipes
* Shared Memory

1. What are purposes of Inter process communication?

* Data transfer
* Sharing data
* Event Notification
* Resource sharing and synchronization
* Process control.

1. What are different inter thread communication mechanisms?
   1. Pthread
   2. Tickets
   3. locks
2. What are Volatile variables?

* Volatile is compiler directive, suggesting that variable shall be read from memory, it can be beyond CPU control.

1. What is concurrency?

* Concurrent means something that happens at the same time as something else.
* Concurrency is tendency for things to happen at the same time in a system.
* Concurrency is interleaving of processes in time to give the appearance of simultaneous execution. It differs from parallelism, which offers genuine simultaneous execution.

1. What is parallelism?

* Parallelism is actual simultaneous execution of more than one execution units.
* Parallelism has to be supported by hardware, multi core processors.

1. How to achieve synchronization in following cases?
   1. Single read thread and single write thread.
   2. Single write thread and multiple read threads.
   3. Multiple write threads and multiple read threads.
2. How to know how much memory used by process?

* valgrind

1. What is difference between compiler and interpreter?

Compiler Interpreter

1. Entire program as input Single instruction as input.
2. Intermediated object code is generated No intermediate object code is generated.
3. Faster execution Slower execution
4. More memory requirements less memory requirement.
5. What is marshaling?

* This is related to remote procedure call.
* Calling a function from one process from another.
* It uses the proxy-adaptor design pattern.

1. What is priority inversion?

* Priority inversion is a problematic scenario in scheduling in which a high priority task is indirectly preempted by a medium priority task effectively inverting the relative priorities of two tasks.

1. What is context switching?

* Whenever an interrupt arrives, the CPU must do a state-save of currently running process, then switch into kernel mode to handle the interrupt and then do a state-restore of interrupted process
* Similarly a context switch occurs when time slice for one process has expired and a new process is to be loaded from ready queue.

1. What is process spawning?

* When the OS at the explicit request of another process creates a process, this action is called process spawning.

1. What are types of scheduling?
2. Explain short, long and medium term scheduling.
3. What is busy waiting? What other kind of waiting are there in operating system? Can busy waiting be avoided altogether?

* Busy waiting means that a process is waiting for a condition to be satisfied in a tight loop without relinquishing the processor. Alternatively a process could wait by relinquishing the processor and block on a condition wait to be awakened at some appropriate time in the future. Busy waiting can be avoided but incurs the overhead associated with putting a process to sleep and having to wake it up when the appropriate program state is reached.

1. What is difference between the busy waiting and Polling?
   1. Busy Waiting

While(IsMyFileReady())

{

// Do nothing

}

* 1. Polling

While(IsMyFileReady())

{

Sleep(1000);

}

1. What are popular multi-processor thread-scheduling strategies? Explain following strategies.
2. Load sharing
3. Gang scheduling
4. Dedicated processor assignments
5. Dynamic scheduling
6. What are reasons for process suspensions/termination?

* Swapping, interactive user request, timing, parent process request.
* Normal completion
* Memory unavailable
* Protection error
* Privileged instruction
* Human intervention
* Parent request
* Exceed time limit
* Bounds violation
* Arithmetic error
* Invalid Instruction
* Parent termination
* I/O failure.

1. What is process migration?

* Process migration is the act of transferring a process between two machines. It enables dynamic load distribution, fault resilience, eased system administration and data access locality.

1. Explain memory partitions, paging and segmentation.

* Physical memory is broken up into fixed partitions.
* Paging: Paging solves the external fragmentation problem by using fixed sized units in both physical and virtual memory.
* Segmentation: Segmentation is a technique that partitions memory into logical related data units
  + Modules, Procedures, stack, data, file

1. What is semaphore?
2. What is mutex?
3. What is difference between socket and pipe?
4. What is monitor?
5. What is difference between semaphore and monitor?
6. What are different thread attributes?
7. What are different types of semaphores?
8. What are different types of mutex?
9. What is difference between semaphore, mutex and binary semaphore?
10. What are spinlocks?
11. Write programs for each for following cases
    1. signals
    2. pipes
    3. named pipes
    4. sockets
    5. message queue
    6. semaphore
    7. shared memory
    8. streams
    9. Mailbox
    10. Mutex
    11. Conditional variable
    12. Spin lock

Reference

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2. <https://www.cs.uic.edu/~jbell/CourseNotes/OperatingSystems/3_Processes.html>
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5. <http://www.csl.mtu.edu/cs4411.ck/www/NOTES/signal/kill.html>
6. <http://www.cs.tufts.edu/comp/150PPP/notes/perl_ipc.php>
7. http://www.parashift.com/c++-faq/

Some questions from <https://isocpp.org/wiki/faq/ctors>

1. What’s is deal with constructors?

* Constructors built objects from dust.
* They initialize objects
* They may allocate the resources memory, files, semaphores, sockets etc.

1. What is difference between List x and List x()?

* One is object declaration and other one is function declaration

1. Can one constructor of a class call another constructor of same class to initialize this object?

* Till time no,
* So how to achieve it?
  1. Use parametrized constructor with default values
  2. Use separate init function
  3. Use functors

1. Default constructor for Fred, Any one of following will work as default constructor for Fred.

* Fred()
* Fred (int a = 0)
* Fred (int a = 10, int j = 19);

1. Constructor invocation for array of objects?

* Default constructors will get invoked

1. How to invoke parametrized constructor for arrays?
   1. Use vectors instead
      * Whenever you use vector for user defined class, define copy constructor.
   2. Use explicit initialization of arrays.
2. Initialization list vs assignments