योगः कर्मसु कौशलम्
IN PURSUIT OF PERFECTION

VIVEKANANDA INSTITUTE OF PROFESSIONAL STUDIES - TECHNICAL CAMPUS

Grade A++ Accredited Institution by NAAC

NBA Accredited for MCA Programme; Recognized under Section 2(f) by UGC;
Affiliated to GGSIP University, Delhi; Recognized by Bar Council of India and AICTE
An ISO 9001:2015 Certified Institution

SCHOOL OF ENGINEERING & TECHNOLOGY

B.Tech Programme: Computer Science & Engineering

Course Title: Distributed Systems and Cloud Computing Lab

Course Code: CIE-407P

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Submitted By:

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Branch & Section: CSE-B

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VISION OF INSTITUTE

To be an educational institute that empowers the field of engineering to build a sustainable future by providing quality education with innovative practices that supports people, planet and profit.

MISSION OF INSTITUTE

To groom the future engineers by providing value-based education and awakening students' curiosity, nurturing creativity and building capabilities to enable them to make significant contributions to the world.

VIPS
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SCHOOL OF ENGINEERING & TECHNOLOGY

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S.no	EXPERIMENT	Date	Marks			Remark	Updated Marks	Faculty Signature
			Laboratory Assessment	Class Participation	Viva			

EXPERIMENT - 1

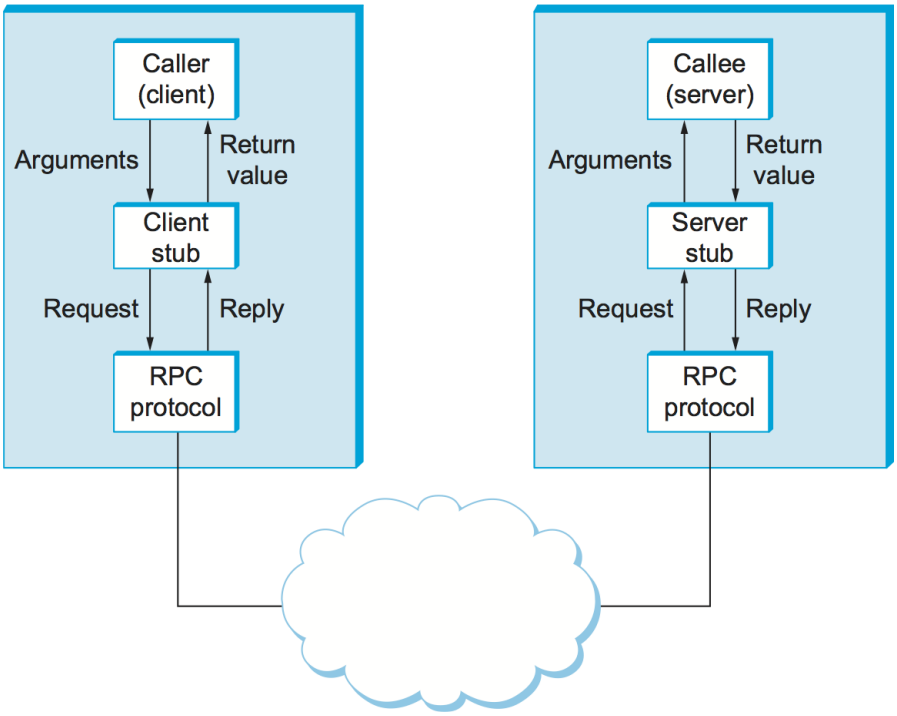
AIM: Write a Program in Java to implement RPC

THEORY:

A **Remote Procedure Call (RPC)** is a protocol that allows a program on one computer (the **client**) to execute procedures (methods/functions) on another computer (the **server**) as if they were local.
It hides the complexity of network communication → the programmer just calls a method, and the underlying system handles message passing, marshalling, and network transport.

Key Characteristics

- **Transparency**: Client calls remote methods just like local ones.
- **Language independent**: RPC can work across different programming languages (via IDL – Interface Definition Language).
- **Communication**: Uses request–response over a network (TCP/UDP).
- **Client-Server model**: The client initiates, the server executes.



Architecture of RPC
Advantages

- Simplifies distributed computing.
- Hides details of network programming (no sockets needed for the user).
- Increases modularity (clients and servers can evolve separately).

Disadvantages

- **Overhead**: More expensive than local calls due to network latency.
- **Partial failures**: If the server or network fails, the client might hang or crash.
- **Not transparent for non-functional aspects**: E.g., performance, failures, and security issues are different from local calls.

CODE:

Server.java

```
package rpcpassword;

import java.net.*;
import java.io.*;

public class server {
   public static void main(String[] args) {
      try (ServerSocket serverSocket = new ServerSocket(6000)) {
         System.out.println("\nServer listening on port 6000\n");
         while (true) {
            Socket clientSocket = serverSocket.accept();
            new Thread(() -> {
               try (BufferedReader in = new BufferedReader(new InputStreamReader(clientSocket.getInputStream()));
                   PrintWriter out = new PrintWriter(clientSocket.getOutputStream(), true)) {

                  String request = in.readLine();
                  System.out.println("Received password from client: " + request);

                  if ("password123".equals(request)) {
                     out.println("Access granted\n");
                     System.out.println("Access granted to client\n");
                  } else {
                     out.println("Access denied\n");
                     System.out.println("Access denied to client - incorrect password\n");
                  }

               } catch (IOException e) {
                  System.err.println("Client error: " + e.getMessage());
               }
            }).start();
         }
      } catch (IOException e) {
         System.err.println("Server error: " + e.getMessage());
      }
   }

}
```

Client.java

```
package rpcpassword;

import java.net.*;
import java.io.*;
import java.util.Scanner;

public class client {
   public static void main(String[] args) {
      try (Socket socket = new Socket("localhost", 6000)) {
         PrintWriter out = new PrintWriter(socket.getOutputStream(), true);
         BufferedReader in = new BufferedReader(new InputStreamReader(socket.getInputStream()));
         Scanner scanner = new Scanner(System.in);

         System.out.print("\nEnter password: ");
         String password = scanner.nextLine();

         out.println(password);

         String response = in.readLine();
         System.out.println("Server response: " + response);

         scanner.close();
      } catch (IOException e) {
```

```
        System.err.println("Client error: " + e.getMessage());
    }
  }
}
```

OUTPUT:

Server

```
Server (1) [Java Application] C:\Users\Aditya Jindal\.p2\pool\plugins\org.eclipse.justj.openjdk.hotspot.jre.full.win32.x86_64_21.0.7.v20250502-0916\jre\bin\javaw.exe (16-Sept-2025, 10:09:17 pm elaps
Server listening on port 6000
Received password from client: password123
Access granted to client
```

Client

```
<terminated> Client [Java Application] C:\Users\Aditya Jindal\.p2\pool\plugins\org.eclipse.justj.openjdk.hotspot.jre.full.win32.x86_64_21.0.7.v20250502-0916\jre\bin\javaw.exe (16-Sept-2025, 10:09:3
Enter password: password123
Server response: Access granted
```

LEARNING OUTCOME:

EXPERIMENT - 2

AIM: Implement the concept of Remote Method Invocation in Java.

THEORY:
Remote Method Invocation (RMI) is Java's mechanism to implement Remote Procedure Calls (RPC) in an object-oriented way.
It allows a Java program running on one Java Virtual Machine (JVM) to invoke methods of an object running on another JVM, possibly on a different machine, as if the method were local.

Key Features
- Purely Java-based distributed computing.
- Provides location transparency: the client does not need to know where the object is running.
- Supports object serialization: allows passing complex objects (not just primitive data types) across the network.
- Built-in security manager and exception handling for remote operations.

RMI Components
1. Remote Interface
   - Declares methods that can be invoked remotely.
   - Must extend java.rmi.Remote.
   - Methods must throw RemoteException.
2. Remote Object Implementation
   - Class that provides the actual logic.
   - Must extend UnicastRemoteObject.
3. Stub (Client-side proxy)
   - Acts as a placeholder for the remote object.
   - Handles method call forwarding to the server.
4. Skeleton (Server-side proxy) *(in older Java versions)*
   - Received requests from stub and forwarded them to the actual remote object.
   - From Java 2 onwards, skeletons are generated automatically inside JVM.
5. RMI Registry
   - A naming service where remote objects are registered.
   - Clients use it to look up objects using a URL-like name

Advantages of RMI
- **Simplicity**: Hides low-level socket communication.
- **Object-oriented**: Works directly with Java objects.
- **Reusability**: Remote services can be reused across applications.
- **Built-in security**: Supports access restrictions via security manager.

Limitations
- Java-only: Cannot directly interact with non-Java systems (unlike gRPC or CORBA).
- Network overhead: Slower than local calls.
- Requires JVM on both client and server.

CODE:

Adder.java
```
package rmi;
import java.rmi.*;

public interface Adder extends Remote {
 int add(int a, int b) throws RemoteException;
}
```

AdderClient.java

```
package rmi;

import java.rmi.*;

public class AdderClient {
   public static void main(String[] args) {
      try {
         Adder stub = (Adder) Naming.lookup("rmi://localhost/AdderService");
         int result = stub.add(9, 7);
         System.out.println("Result: " + result);
      } catch (Exception e) {
         System.out.println("Client exception: " + e);
      }
   }
}
```

AdderImpl.java

```
package rmi;

import java.rmi.*;
import java.rmi.server.*;

public class AdderImpl extends UnicastRemoteObject implements Adder {
   AdderImpl() throws RemoteException {
      super();
   }

   public int add(int a, int b) throws RemoteException {
      return a + b;
   }

   public static void main(String[] args) {
      try {
         AdderImpl obj = new AdderImpl();
         Naming.rebind("rmi://localhost/AdderService", obj);
         System.out.println("Adder Service is running...");
      } catch (Exception e) {
         System.out.println("Server exception: " + e);
      }
   }
}
```

OUTPUT:

```
C:\Users\Aditya Jindal\eclipse-workspace\DSCC\bin>java rmi.AdderImpl
AdderService is bound and ready...
```

```
C:\Users\Aditya Jindal\eclipse-workspace\DSCC\bin>java rmi.AdderClient
Result: 30

C:\Users\Aditya Jindal\eclipse-workspace\DSCC\bin>
```

LEARNING OUTCOME: