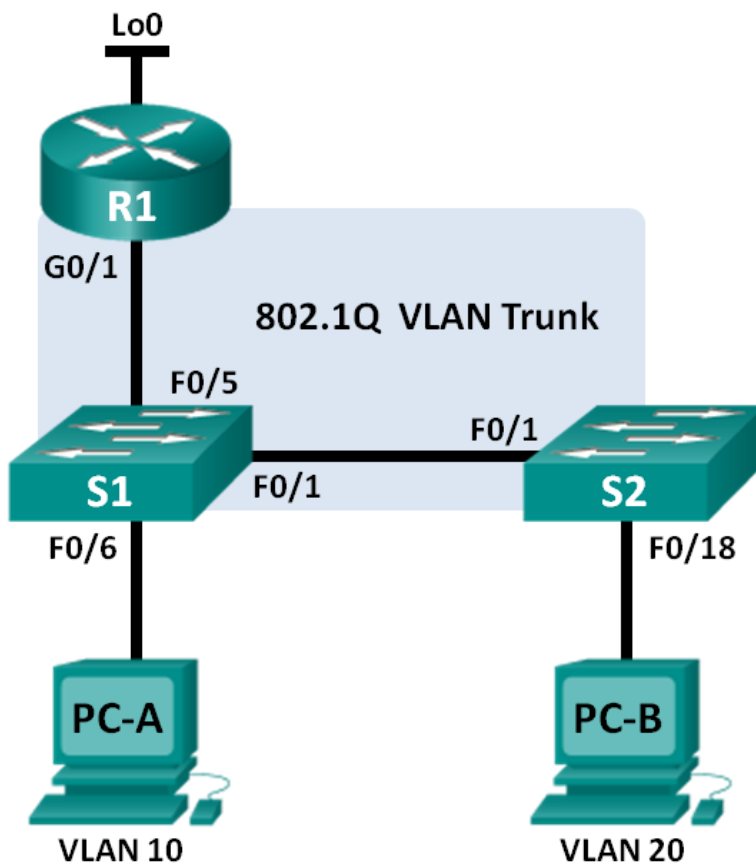


## Lab – Configuring 802.1Q Trunk-Based Inter-VLAN Routing (Solution)

### Topology



## Addressing Table

| Device | Interface | IP Address      | Subnet Mask     | Default Gateway |
|--------|-----------|-----------------|-----------------|-----------------|
| R1     | G0/1.1    | 192.168.1.1     | 255.255.255.0   | N/A             |
|        | G0/1.10   | 192.168.10.1    | 255.255.255.0   | N/A             |
|        | G0/1.20   | 192.168.20.1    | 255.255.255.0   | N/A             |
|        | Lo0       | 209.165.200.225 | 255.255.255.224 | N/A             |
| S1     | VLAN 1    | 192.168.1.11    | 255.255.255.0   | 192.168.1.1     |
| S2     | VLAN 1    | 192.168.1.12    | 255.255.255.0   | 192.168.1.1     |
| PC-A   | NIC       | 192.168.10.3    | 255.255.255.0   | 192.168.10.1    |
| PC-B   | NIC       | 192.168.20.3    | 255.255.255.0   | 192.168.20.1    |

## Switch Port Assignment Specifications

| Ports    | Assignment         | Network         |
|----------|--------------------|-----------------|
| S1 F0/1  | 802.1Q Trunk       | N/A             |
| S2 F0/1  | 802.1Q Trunk       | N/A             |
| S1 F0/5  | 802.1Q Trunk       | N/A             |
| S1 F0/6  | VLAN 10 – Students | 192.168.10.0/24 |
| S2 F0/18 | VLAN 20 – Faculty  | 192.168.20.0/24 |

## Objectives

**Part 1: Build the Network and Configure Basic Device Settings**

**Part 2: Configure Switches with VLANs and Trunking**

**Part 3: Configure Trunk-Based Inter-VLAN Routing**

## Background / Scenario

A second method of providing routing and connectivity for multiple VLANs is through the use of an 802.1Q trunk between one or more switches and a single router interface. This method is also known as router-on-a-stick inter-VLAN routing. In this method, the physical router interface is divided into multiple subinterfaces that provide logical pathways to all VLANs connected.

In this lab, you will configure trunk-based inter-VLAN routing and verify connectivity to hosts on different VLANs as well as with a loopback on the router.

**Note:** This lab provides minimal assistance with the actual commands necessary to configure trunk-based inter-VLAN routing. However, the required configuration commands are provided in Appendix A of this lab. Test your knowledge by trying to configure the devices without referring to the appendix.

**Note:** The routers used with CCNA hands-on labs are Cisco 1941 Integrated Services Routers (ISRs) with Cisco IOS, Release 15.2(4)M3 (universalk9 image). The switches used are Cisco Catalyst 2960s with Cisco IOS, Release 15.0(2) (lanbasek9 image). Other routers, switches and Cisco IOS versions can be used. Depending on the model and Cisco IOS version, the commands available and output produced might vary

from what is shown in the labs. Refer to the Router Interface Summary Table at the end of the lab for the correct interface identifiers.

**Note:** Make sure that the routers and switches have been erased and have no startup configurations. If you are unsure, contact your instructor.

### Required Resources

- 1 Router (Cisco 1941 with Cisco IOS, release 15.2(4)M3 universal image or comparable)
- 2 Switches (Cisco 2960 with Cisco IOS, release 15.0(2) lanbasek9 image or comparable)
- 2 PCs (Windows 7, Vista, or XP with terminal emulation program, such as Tera Term)
- Console cables to configure the Cisco IOS devices via the console ports
- Ethernet cables as shown in the topology

### Part 1: Build the Network and Configure Basic Device Settings

In Part 1, you will set up the network topology and configure basic settings on the PC hosts, switches, and router.

**Step 1: Cable the network as shown in the topology.**

**Step 2: Configure PC hosts.**

**Step 3: Initialize and reload the router and switches as necessary.**

**Step 4: Configure basic settings for each switch.**

- a. Console into the switch and enter global configuration mode.
- b. Copy the following basic configuration and paste it to the running-configuration on the switch.

```
no ip domain-lookup
service password-encryption
enable secret class
banner motd #
Unauthorized access is strictly prohibited. #
line con 0
password cisco
login
logging synchronous
line vty 0 15
password cisco
login
exit
```

- c. Configure the device name as shown in the topology.
- d. Configure the IP address listed in the Addressing Table for VLAN 1 on the switch.
- e. Configure the default gateway on the switch.
- f. Administratively deactivate all unused ports on the switch.
- g. Copy the running configuration to the startup configuration.

### Step 5: Configure basic settings for the router.

- Console into the router and enter global configuration mode.
- Copy the following basic configuration and paste it to the running-configuration on the router.

```
no ip domain-lookup
hostname R1
service password-encryption
enable secret class
banner motd #
Unauthorized access is strictly prohibited. #
Line con 0
password cisco
login
logging synchronous
line vty 0 4
password cisco
login
```
- Configure the Lo0 IP address as shown in the Address Table. Do not configure sub-interfaces at this time. They will be configured in Part 3.
- Copy the running configuration to the startup configuration.

## Part 2: Configure Switches with VLANs and Trunking

In Part 2, you will configure the switches with VLANs and trunking.

**Note:** The required commands for Part 2 are provided in Appendix A. Test your knowledge by trying to configure S1 and S2 without referring to the appendix.

### Step 1: Configure VLANs on S1.

- On S1, configure the VLANs and names listed in the Switch Port Assignment Specifications table. Write the commands you used in the space provided.

---

---

---

---

```
S1(config)# vlan 10
S1(config-vlan)# name Students
S1(config-vlan)# vlan 20
S1(config-vlan)# name Faculty
S1(config-vlan)# exit
```

- On S1, configure the interface connected to R1 as a trunk. Also configure the interface connected to S2 as a trunk. Write the commands you used in the space provided.

---

---

```
S1(config)# interface f0/5
```

```
S1(config-if)# switchport mode trunk
```

```
S1(config-if)# interface f0/1
```

```
S1(config-if)# switchport mode trunk
```

- c. On S1, assign the access port for PC-A to VLAN 10. Write the commands you used in the space provided.

---

---

---

```
S1(config)# interface f0/6
```

```
S1(config-if)# switchport mode access
```

```
S1(config-if)# switchport access vlan 10
```

### Step 2: Configure VLANs on Switch 2.

- a. On S2, configure the VLANs and names listed in the Switch Port Assignment Specifications table.
- b. On S2, verify that the VLAN names and numbers match those on S1. Write the command you used in the space provided.

```
S2# show vlan brief
```

```
S2# show vlan brief
```

| VLAN | Name               | Status | Ports   |
|------|--------------------|--------|---|
| 1    | default            | active | Fa0/1, Fa0/2, Fa0/3, Fa0/4, Fa0/5<br>Fa0/6, Fa0/7, Fa0/8, Fa0/9<br>Fa0/10, Fa0/11, Fa0/12, Fa0/13<br>Fa0/14, Fa0/15, Fa0/16, Fa0/17<br>Fa0/18, Fa0/19, Fa0/20, Fa0/21<br>Fa0/22, Fa0/23, Fa0/24, Gi0/1<br>Gi0/2 |
| 10   | Students           | active |   |
| 20   | Faculty            | active |   |
| 1002 | fddi-default       | active |   |
| 1003 | token-ring-default | active |   |
| 1004 | fddinet-default    | active |   |
| 1005 | trnet-default      | active |   |

- c. On S2, assign the access port for PC-B to VLAN 20.
- d. On S2, configure the interface connected to S1 as a trunk.

### Part 3: Configure Trunk-Based Inter-VLAN Routing

In Part 3, you will configure R1 to route to multiple VLANs by creating subinterfaces for each VLAN. This method of inter-VLAN routing is called router-on-a-stick.

**Note:** The required commands for Part 3 are provided in Appendix A. Test your knowledge by trying to configure trunk-based or router-on-a-stick inter-VLAN routing without referring to the appendix.

### Step 1: Configure a subinterface for VLAN 1.

- Create a subinterface on R1 G0/1 for VLAN 1 using 1 as the subinterface ID. Write the command you used in the space provided.

---

```
R1(config)# interface g0/1.1
```

- Configure the subinterface to operate on VLAN 1. Write the command you used in the space provided.

---

```
R1(config-subif)# encapsulation dot1q 1
```

- Configure the subinterface with the IP address from the Address Table. Write the command you used in the space provided.

---

```
R1(config-subif)# ip address 192.168.1.1 255.255.255.0
```

### Step 2: Configure a subinterface for VLAN 10.

- Create a subinterface on R1 G0/1 for VLAN 10 using 10 as the subinterface ID.
- Configure the subinterface to operate on VLAN 10.
- Configure the subinterface with the address from the Address Table.

### Step 3: Configure a subinterface for VLAN 20.

- Create a subinterface on R1 G0/1 for VLAN 20 using 20 as the subinterface ID.
- Configure the subinterface to operate on VLAN 20.
- Configure the subinterface with the address from the Address Table.

### Step 4: Enable the G0/1 interface.

Enable the G0/1 interface. Write the commands you used in the space provided.

---

```
R1(config)# interface g0/1
R1(config-if)# no shutdown
```

### Step 5: Verify connectivity.

Enter the command to view the routing table on R1. What networks are listed?

---

```
192.168.1.0, 192.168.10.0, 192.168.20.0, and 209.165.200.224
```

```
R1# show ip route
```

```
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route
```

Gateway of last resort is not set

```
192.168.1.0/24 is variably subnetted, 2 subnets, 2 masks
C    192.168.1.0/24 is directly connected, GigabitEthernet0/1.1
L    192.168.1.1/32 is directly connected, GigabitEthernet0/1.1
192.168.10.0/24 is variably subnetted, 2 subnets, 2 masks
C    192.168.10.0/24 is directly connected, GigabitEthernet0/1.10
L    192.168.10.1/32 is directly connected, GigabitEthernet0/1.10
192.168.20.0/24 is variably subnetted, 2 subnets, 2 masks
C    192.168.20.0/24 is directly connected, GigabitEthernet0/1.20
L    192.168.20.1/32 is directly connected, GigabitEthernet0/1.20
209.165.200.0/24 is variably subnetted, 2 subnets, 2 masks
C    209.165.200.224/27 is directly connected, Loopback0
L    209.165.200.225/32 is directly connected, Loopback0
```

From PC-A, is it possible to ping the default gateway for VLAN 10? \_\_\_\_\_ **Yes**

From PC-A, is it possible to ping PC-B? \_\_\_\_\_ **Yes**

From PC-A, is it possible to ping Lo0? \_\_\_\_\_ **Yes**

From PC-A, is it possible to ping S2? \_\_\_\_\_ **Yes**

If the answer is **no** to any of these questions, troubleshoot the configurations and correct any errors.

### Reflection

What are the advantages of trunk-based or router-on-a-stick inter-VLAN routing?

---

Router-on-a-stick inter-VLAN routing allows for one interface to route to multiple VLANs unlike the legacy inter-VLAN method which requires one port per VLAN.

## Router Interface Summary Table

| Router Interface Summary  |                             |                             |                       |                       |
|---|-----------------------------|-----------------------------|-----------------------|-----------------------|
| Router Model  | Ethernet Interface #1       | Ethernet Interface #2       | Serial Interface #1   | Serial Interface #2   |
| 1800  | Fast Ethernet 0/0 (F0/0)    | Fast Ethernet 0/1 (F0/1)    | Serial 0/0/0 (S0/0/0) | Serial 0/0/1 (S0/0/1) |
| 1900  | Gigabit Ethernet 0/0 (G0/0) | Gigabit Ethernet 0/1 (G0/1) | Serial 0/0/0 (S0/0/0) | Serial 0/0/1 (S0/0/1) |
| 2801  | Fast Ethernet 0/0 (F0/0)    | Fast Ethernet 0/1 (F0/1)    | Serial 0/1/0 (S0/1/0) | Serial 0/1/1 (S0/1/1) |
| 2811  | Fast Ethernet 0/0 (F0/0)    | Fast Ethernet 0/1 (F0/1)    | Serial 0/0/0 (S0/0/0) | Serial 0/0/1 (S0/0/1) |
| 2900  | Gigabit Ethernet 0/0 (G0/0) | Gigabit Ethernet 0/1 (G0/1) | Serial 0/0/0 (S0/0/0) | Serial 0/0/1 (S0/0/1) |
| <p><b>Note:</b> To find out how the router is configured, look at the interfaces to identify the type of router and how many interfaces the router has. There is no way to effectively list all the combinations of configurations for each router class. This table includes identifiers for the possible combinations of Ethernet and Serial interfaces in the device. The table does not include any other type of interface, even though a specific router may contain one. An example of this might be an ISDN BRI interface. The string in parenthesis is the legal abbreviation that can be used in Cisco IOS commands to represent the interface.</p> |                             |                             |                       |                       |

## Appendix A – Configuration Commands

### Switch S1

```

S1(config)# vlan 10
S1(config-vlan)# name Students
S1(config-vlan)# vlan 20
S1(config-vlan)# name Faculty
S1(config-vlan)# exit
S1(config)# interface f0/1
S1(config-if)# switchport mode trunk
S1(config-if)# interface f0/5
S1(config-if)# switchport mode trunk
S1(config-if)# interface f0/6
S1(config-if)# switchport mode access
S1(config-if)# switchport access vlan 10

```

### Switch S2

```

S2(config)# vlan 10
S2(config-vlan)# name Students
S2(config-vlan)# vlan 20
S2(config-vlan)# name Faculty
S2(config)# interface f0/1
S2(config-if)# switchport mode trunk

```



```
S2(config-if)# interface f0/18
S2(config-if)# switchport mode access
S2(config-if)# switchport access vlan 20
```

### Router R1

```
R1(config)# interface g0/1.1
R1(config-subif)# encapsulation dot1Q 1
R1(config-subif)# ip address 192.168.1.1 255.255.255.0
R1(config-subif)# interface g0/1.10
R1(config-subif)# encapsulation dot1Q 10
R1(config-subif)# ip address 192.168.10.1 255.255.255.0
R1(config-subif)# interface g0/1.20
R1(config-subif)# encapsulation dot1Q 20
R1(config-subif)# ip address 192.168.20.1 255.255.255.0
R1(config-subif)# exit
R1(config)# interface g0/1
R1(config-if)# no shutdown
```

### Device Configs

**Note:** The VLANs configured do not display in the switch running configuration but are stored in the vlan.dat file. The output from the **show vlan brief** command is provided.

### Router R1

```
R1# show run
Building configuration...

Current configuration : 1731 bytes
!
version 15.2
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname R1
!
boot-start-marker
boot-end-marker
!
!
enable secret 4 06YFDUHH61wAE/kLkDq9BGho1QM5EnRtoyr8cHAUg.2
!
no aaa new-model
!
!
!
!
!
```

```
!  
no ip domain lookup  
ip cef  
no ipv6 cef  
!  
multilink bundle-name authenticated  
!  
!  
!  
!  
redundancy  
!  
!  
!  
!  
!  
!  
!  
!  
!  
!  
!  
!  
interface Loopback0  
 ip address 209.165.200.225 255.255.255.224  
!  
interface Embedded-Service-Engine0/0  
 no ip address  
 shutdown  
!  
interface GigabitEthernet0/0  
 no ip address  
 shutdown  
 duplex auto  
 speed auto  
!  
interface GigabitEthernet0/1  
 no ip address  
 duplex auto  
 speed auto  
!  
interface GigabitEthernet0/1.1  
 encapsulation dot1Q 1  
 ip address 192.168.1.1 255.255.255.0  
!  
interface GigabitEthernet0/1.10  
 encapsulation dot1Q 10  
 ip address 192.168.10.1 255.255.255.0
```

## Lab – Configuring 802.1Q Trunk-Based Inter-VLAN Routing

---

```
!  
interface GigabitEthernet0/1.20  
  encapsulation dot1Q 20  
  ip address 192.168.20.1 255.255.255.0  
!  
interface Serial0/0/0  
  no ip address  
  shutdown  
  clock rate 2000000  
!  
interface Serial0/0/1  
  no ip address  
  shutdown  
!  
ip forward-protocol nd  
!  
no ip http server  
no ip http secure-server  
!  
!  
!  
!  
!  
control-plane  
!  
!  
!  
line con 0  
  password cisco  
  logging synchronous  
  login  
line aux 0  
line 2  
  no activation-character  
  no exec  
  transport preferred none  
  transport input all  
  transport output pad telnet rlogin lapb-ta mop udptn v120 ssh  
  stopbits 1  
line vty 0 4  
  password cisco  
  login  
  transport input all  
!  
scheduler allocate 20000 1000  
!  
end
```

### Switch S1

```
S1# show vlan brief
```

| VLAN Name               | Status    | Ports   |
|-------------------------|-----------|---|
| -----                   |           |   |
| 1 default               | active    | Fa0/2, Fa0/3, Fa0/4, Fa0/5<br>Fa0/7, Fa0/8, Fa0/9, Fa0/10<br>Fa0/11, Fa0/12, Fa0/13, Fa0/14<br>Fa0/15, Fa0/16, Fa0/17, Fa0/18<br>Fa0/19, Fa0/20, Fa0/21, Fa0/22<br>Fa0/23, Fa0/24, Gi0/1, Gi0/2 |
| 10 Students             | active    | Fa0/6   |
| 20 Faculty              | active    |   |
| 1002 fddi-default       | act/unsup |   |
| 1003 token-ring-default | act/unsup |   |
| 1004 fddinet-default    | act/unsup |   |
| 1005 trnet-default      | act/unsup |   |

```
S1# show run
```

```
Building configuration...
```

```
Current configuration : 1627 bytes
```

```
!  
version 15.0  
no service pad  
service timestamps debug datetime msec  
service timestamps log datetime msec  
no service password-encryption  
!  
hostname S1  
!  
boot-start-marker  
boot-end-marker  
!  
enable secret 4 06YFDUHH61wAE/kLkDq9BGholQM5EnRtoyr8cHAUg.2  
!  
no aaa new-model  
system mtu routing 1500  
!  
!  
no ip domain-lookup  
!  
!  
!  
!  
!  
!  
!
```

## Lab – Configuring 802.1Q Trunk-Based Inter-VLAN Routing

---

```
spanning-tree mode pvst
spanning-tree extend system-id
!
vlan internal allocation policy ascending
!
!
!
!
!
!
interface FastEthernet0/1
  switchport mode trunk
!
interface FastEthernet0/2
shutdown
!
interface FastEthernet0/3
shutdown
!
interface FastEthernet0/4
shutdown
!
interface FastEthernet0/5
  switchport mode trunk
!
interface FastEthernet0/6
  switchport access vlan 10
  switchport mode access
!
interface FastEthernet0/7
shutdown
!
interface FastEthernet0/8
shutdown
!
interface FastEthernet0/9
shutdown
!
interface FastEthernet0/10
shutdown
!
interface FastEthernet0/11
shutdown
!
interface FastEthernet0/12
shutdown
!
interface FastEthernet0/13
shutdown
```

```
!  
interface FastEthernet0/14  
shutdown  
!  
interface FastEthernet0/15  
shutdown  
!  
interface FastEthernet0/16  
shutdown  
!  
interface FastEthernet0/17  
shutdown  
!  
interface FastEthernet0/18  
shutdown  
!  
interface FastEthernet0/19  
shutdown  
!  
interface FastEthernet0/20  
shutdown  
!  
interface FastEthernet0/21  
shutdown  
!  
interface FastEthernet0/22  
shutdown  
!  
interface FastEthernet0/23  
shutdown  
!  
interface FastEthernet0/24  
shutdown  
!  
interface GigabitEthernet0/1  
shutdown  
!  
interface GigabitEthernet0/2  
shutdown  
!  
interface Vlan1  
ip address 192.168.1.11 255.255.255.0  
!  
ip default-gateway 192.168.1.1  
ip http server  
ip http secure-server  
!  
!  
!
```

## Lab – Configuring 802.1Q Trunk-Based Inter-VLAN Routing

---

```
line con 0
password cisco
logging synchronous
login
line vty 0 4
password cisco
login
line vty 5 15
password cisco
login
!
end
```

### Switch S2

```
S2# show vlan brief
```

| VLAN | Name               | Status    | Ports  |
|------|--------------------|-----------|--|
| 1    | default            | active    | Fa0/2, Fa0/3, Fa0/4, Fa0/5<br>Fa0/6, Fa0/7, Fa0/8, Fa0/9<br>Fa0/10, Fa0/11, Fa0/12, Fa0/13<br>Fa0/14, Fa0/15, Fa0/16, Fa0/17<br>Fa0/19, Fa0/20, Fa0/21, Fa0/22<br>Fa0/23, Fa0/24, Gi0/1, Gi0/2 |
| 10   | Students           | active    |  |
| 20   | Faculty            | active    | Fa0/18   |
| 1002 | fddi-default       | act/unsup |  |
| 1003 | token-ring-default | act/unsup |  |
| 1004 | fddinet-default    | act/unsup |  |
| 1005 | trnet-default      | act/unsup |  |

```
S2# show run
```

```
Building configuration...
```

```
Current configuration : 1633 bytes
```

```
!
version 15.0
no service pad
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname S2
!
boot-start-marker
boot-end-marker
!
enable secret 4 06YFDUHH61wAE/kLkDq9BGho1QM5EnRtoyr8cHAUg.2
!
```

```
no aaa new-model
system mtu routing 1500
!
!
no ip domain-lookup
!
!
!
!
!
!
!
!
spanning-tree mode pvst
spanning-tree extend system-id
!
vlan internal allocation policy ascending
!
!
!
!
!
!
interface FastEthernet0/1
 switchport mode trunk
!
interface FastEthernet0/2
 shutdown
!
interface FastEthernet0/3
 shutdown
!
interface FastEthernet0/4
 shutdown
!
interface FastEthernet0/5
 shutdown
!
interface FastEthernet0/6
 shutdown
!
interface FastEthernet0/7
 shutdown
!
interface FastEthernet0/8
 shutdown
!
interface FastEthernet0/9
 shutdown
```



```
!  
interface FastEthernet0/10  
shutdown  
!  
interface FastEthernet0/11  
shutdown  
!  
interface FastEthernet0/12  
shutdown  
!  
interface FastEthernet0/13  
shutdown  
!  
interface FastEthernet0/14  
shutdown  
!  
interface FastEthernet0/15  
shutdown  
!  
interface FastEthernet0/16  
shutdown  
!  
interface FastEthernet0/17  
shutdown  
!  
interface FastEthernet0/18  
  switchport access vlan 20  
  switchport mode access  
!  
interface FastEthernet0/19  
shutdown  
!  
interface FastEthernet0/20  
shutdown  
!  
interface FastEthernet0/21  
shutdown  
!  
interface FastEthernet0/22  
shutdown  
!  
interface FastEthernet0/23  
shutdown  
!  
interface FastEthernet0/24  
shutdown  
!  
interface GigabitEthernet0/1  
shutdown
```

## Lab – Configuring 802.1Q Trunk-Based Inter-VLAN Routing

---

```
!  
interface GigabitEthernet0/2  
shutdown  
!  
interface Vlan1  
ip address 192.168.1.12 255.255.255.0  
!  
ip default-gateway 192.168.1.1  
ip http server  
ip http secure-server  
!  
!  
line con 0  
password cisco  
logging synchronous  
login  
line vty 0 4  
password cisco  
login  
line vty 5 15  
password cisco  
login  
!  
end
```