OLLSCOIL NA GAILLIMHE
UNIVERSITY OF GALWAY

Semester 1 Examinations 2022-2023

Course Instance Code(s)	3BCT
Exam(s)	BSc in Computer Science & Information Technology
Module Code(s)	CT3531
Module(s)	Networks and Data Communications 2
Paper No.	1
External Examiner(s)	Dr. R. Trestian
Internal Examiner(s)	Prof. M. Madden
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Instructions: Answer any 4 questions.
All questions carry equal marks.

Duration	2 hours
No. of Pages	6
Department(s)	School of Computer Science
Course Co-ordinator(s)	Dr Colm O'Riordan

Requirements:

Release in Exam Venue	Yes	X	No	
MCQ Answersheet	Yes		No	X
Handout	None			
Statistical/ Log Tables	None			
Cambridge Tables	None			
Graph Paper	None			
Log Graph Paper	None			
Other Materials	None			
Graphic material in colour	Yes	X	No	

Question 1

a) Assume that you are working for a large corporation that uses the private IPv4 address range 10.0.0.0/8 for its internal network. The company management wants to be able to provision up to 16 separate sites in Ireland with a subnet for each site, with at least 4000 IPv4 host addresses available per subnet. The company has allocated the range 10.16.0.0/16 for the its operations in Ireland. You are requested to design the network layout. Answer the following questions and fully explain the logic behind each answer:

(i) What subnet mask will need to be used for the company's subnets in Ireland? Fully explain the logic behind your answer. 5 MARKS

(ii) What are the valid host addresses and the broadcast addresses for the first and second subnets in Ireland? 5 MARKS

(iii) The company has operations in 8 other European countries and the company has allocated a /16 address range to each of these countries. These individual /16 address ranges are contiguous and Ireland has been allocated the first of these ranges. What route summary or supernet could be used to define a single routing entry for all of the European address ranges? 3 MARKS

b) Write a short essay, approximately 300 words, on one of the following topics. The essay should include a full description of the topic and also discuss its advantages, disadvantages and competitor technologies (if applicable):

(i) The Domain Name System (DNS)
(ii) The GNS3 Network Simulator
(iii) Internet Exchange Points 12 MARKS

Question 2

A company has an office building that has been fitted out with the Local Area Network topology shown in Figure 1 below:

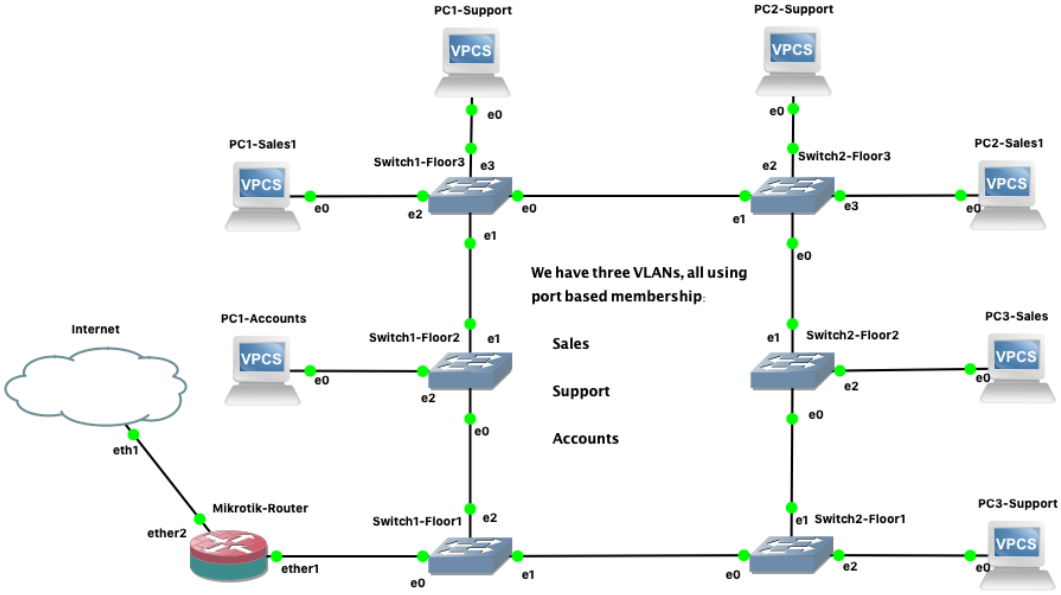

Figure 1 - Local Area Network Topology

The office building has three floors and each floor has two network switches that are used to interconnect with other switches and to connect end user devices e.g. PCs. The company is organised into three departments i.e. Sales, Support and Accounts, each department has its own VLAN. There is also a Mikrotik router connected to one of the switches on the ground floor, this router also provides internet access via an ethernet connection provided by an ISP. Answer the following questions in relation to the design and configuration of this network.

a) What are the advantages of using a VLAN for each department? Suggest a suitable VLAN id and IP subnet for each VLAN. 5 MARKS

b) What port configuration would be required for Switch2-Floor1? In this context explain the purpose of the 802.1q protocol. 5 MARKS

c) What configuration is required on the Mikrotik router to allow it to act as a DHCP server for the various VLANs and to ensure that NAT is used for outgoing internet traffic? The full list of RouterOS commands is not required, just provide a description of the various items that need to be configured. 5 MARKS

d) What steps and additional configuration would be needed on the router and on the switches to add another new VLAN to the existing setup? 5 MARKS

e) What is meant by the term broadcast storm and could this be possible in the topology shown? What mechanism or protocol could be used to ensure that a broadcast storm could not occur? Explain the basic operation of this mechanism. 5 MARKS

Question 3

a) Explain how traceroute works and what it shows. 5 MARKS

b) State and differentiate the three main means of interconnecting an Autonomous System with another Autonomous System. 3 MARKS

c) Describe briefly each of the following: Autonomous System, Border Gateway Protocol, Internet Exchange Point 6 MARKS

d) Describe in your own words what a Route Server is, what function it performs and why it is necessary. 5 MARKS

e) The result of running the command **/ip route print** on a Mikrotik router at the edge of an Autonomous System is shown below. The router has a BGP peering session with a router in a different Autonomous System and it is also running OSPF with other routers in the same Autonomous System:

```
[admin@10.10.10.1] > ip route print
Flags: X - disabled, A - active, D - dynamic,
C - connect, S - static, r - rip, b - bgp, o - ospf, m - mme,
B - blackhole, U - unreachable, P - prohibit
 #      DST-ADDRESS        PREF-SRC        GATEWAY            DISTANCE
 0 ADo  0.0.0.0/0                          10.1.1.2                110
 1 ADC  10.1.1.0/24        10.1.1.1        ether1                    0
 2 ADo  10.1.4.0/24                        10.1.1.2                110
 3 ADC  10.10.10.1/32      10.10.10.1      loopback                  0
 4 ADo  10.10.10.2/32                      10.1.1.2                110
 5 ADo  10.10.10.4/32                      10.1.1.2                110
 6 ADb  10.10.10.5/32                      172.21.1.1               20
 7 ADb  10.10.10.6/32                      172.21.1.1               20
 8 ADb  172.16.1.0/24                      172.21.1.1               20
 9 ADb  172.17.1.0/24                      172.21.1.1               20
10 ADC  172.21.1.0/30      172.21.1.2      ether2                    0
11 ADC  192.168.10.0/24    192.168.10.1    ether3                    0
12 ADo  192.168.11.0/24                   10.1.1.2                110
13 ADo  192.168.12.0/24                   10.1.1.2                110
14 ADo  192.168.81.0/24                   10.1.1.2                110
15 ADC  192.168.182.0/24   192.168.182.138 ether4                    0
```

Answer the following questions in relation to this routing table.

(i) What does the route entry for destination 0.0.0.0/0 mean and why is this route entry particularly important? 2 MARKS

(ii) Is the destination IP range 172.16.1.0/24 in the same Autonomous System or in a different Autonomous System? How can you tell? 2 MARKS

(iii) What is the meaning of the GATEWAY value shown and how might this affect a routing decision? 2 MARKS

Question 4

Assume that an Internet Service Provider has built a routed network in Co Galway as shown in Figure 2 below:

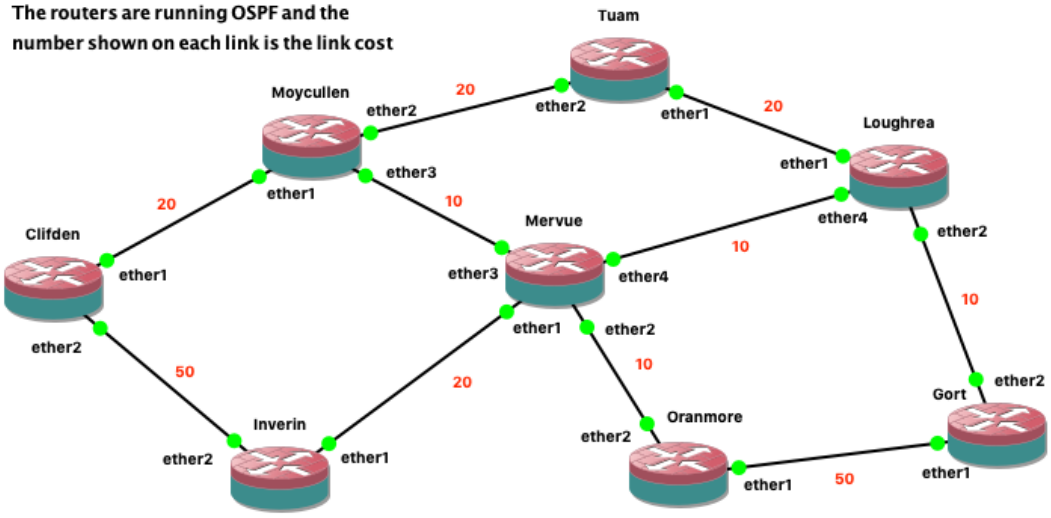

Figure 2 - ISP Regional Network

The routers are all Mikrotik routers running the RouterOS operating system. Answer the following questions in relation to the operation and configuration of this network. Please note that you do not need to build the network shown in the GNS3 simulator to answer these questions.

a) Describe the operation and purpose of the OSPF protocol in the network shown. How is Dijkstra's Algorithm used by OSPF in this context and what would the sink tree look like from the Mervue router? 5 MARKS

b) Describe the format of an OSPF Link State Announcement. Explain how a Link State Announcement from the Loughrea router would be disseminated throughout the network and how can this be done reliably. 5 MARKS

c) Suggest suitable IP subnets for the links connected to the Clifden router. What RouterOS commands are required to assign appropriate IP addresses and to also fully enable OSPF on the Clifden router? 5 MARKS

d) What route would a PC attached to the Clifden router normally take to get to the Gort router? What exactly would happen with OSPF if the link between Mervue and Loughrea became unavailable for some reason? 5 MARKS

e) Assume that the Tuam router needs to have an additional local area network, attached to ether3, for some end user devices e.g. PCs. Suggest a suitable IP subnet for this new local area network. What RouterOS commands would be required on the Tuam router to assign an appropriate IP address for this additional local area network and to ensure that the new IP range is reachable from the other routers in the network? 5 MARKS

Question 5

a) What types of Sockets are supported in the Java networking package and which type of Socket would you recommend for a VOIP type application and a File Transfer type application? 5 MARKS

b) Write a network Server program in Java where the Server waits for incoming client connections using stream type sockets. Once a Client connects it sends a String object to the server with a simple query – the server then responds with a text based response. The connection is then terminated. The server should use a separate thread of execution for each new client connection and all interaction between the Server and the Client should be done within this thread. The answer only needs to include source code for the server side application. 10 MARKS

c) Write another Java application with the same functionality as outlined above, in part b of this question, but this time using Datagram type sockets. Hint: you can use ByteArrayOutputStream and ByteArrayInputStream to populate and read the array associated with the DatagramPacket object. This application does not need to implement a reliable data transfer protocol or use multiple threads at the server for each new client. The answer only needs to include source code for the server side application. 10 MARKS