Level 5 Diploma in Routing (111) 141 Credits

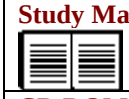
Unit: IP Routing Technology **Exam Paper No.:** 3	**Guided Learning Hours:** 240 **Number of Credits:** 24
Prerequisites: Knowledge in Windows operating system.	**Corequisites:** A pass or higher in Certificate in Networking or equivalence.
Aim: The aim of this unit is to provide learners with in-depth routing terminology knowledge that will increase understanding. Most learners only learn routing terminology when implementing Cisco routers. This gives them a lot of pressure (from setting up the equipment they are not familiar with; to learning terms they have never heard of before – all this becomes too much). The IP Routing Technology unit introduces routing on a platform most comfortable and familiar to many – Windows; and introduce all routing terms in advance before the **Connecting Routing Devices** unit. This unit breaks IP routing technologies into two fundamental pieces: an in depth study of Interior Gateway Protocols (IGPs) and then Exterior Gateway Protocols (EGPs). The IGPs investigation focuses on the study of early versions of Distance Vector Protocols and then the technical details of the modern Link State Protocols such as Open Shortest Path First (OSFP). The EGP investigation focuses on the current version of the Border Gateway Protocol (BGP4) and its use on the Internet. This unit is a map through the jungle of IP Routing technology, focusing particularly on the theory of routing to give learners an insight understand before embarking on the practical activities (Connecting Routing Devices). The unit analyses routing from both a functional and an operational perspective, helping learners make an informed assessment of the merits of routing as an enabling technology. According to various Internet statistics gathered by several resources like Network Wizards, the number of hosts in the *Information Super Highway*, "the Internet", grows exponentially every year! Moreover, new high-bandwidth applications arise (like "Web-TV") or will arise, imposing high "quality of service" demands on ISPs (Internet Service Providers). Therefore; current and future strong demands for high baud/throughput rates per user, as Internet usage increases, require network technology to adapt quickly to the new needs. In this unit, we will examine the factors which restrict or will restrict future required capacity of the network. Those restrictions are based primarily on the bounded capability of future IP (Internet Protocol) routers, to forward "quickly enough" incoming packets to the proper destinations, due to several physical limitations, like finite (not zero) memory access time (needed for searching in the routing table the proper destination port) or switch time (needed to connect input and output ports) of the router. The unit describes the current and future "bottlenecks" of IP routing technology and fundamental quantum mechanical principles. Bandwidth limitations are also considered. However, they are not so critical as the routing ones, as the unit will prove!	
Required Materials: Windows Server Operating System	**Supplementary Materials:** Lecture notes and tutor extra reading recommendations.
Special Requirements: The unit requires a combination of lectures, demonstrations, discussions, and hands-on labs using Windows.	

Intended Learning Outcomes:	**Assessment Criteria:**
1. The OSI reference model concept; how networks and network applications communicate.	1.1 Outline the seven layers of the ISO model 1.2 Analyse how the OSI model works and how data is broken down on each layer. 1.3 Describe the differences between OSI and TCP/IP 1.4 Explain the differences between MAC sublayer and LCC sublayer 1.5 Analyse and justify why DNS uses both TCP and UDP
2. The Internet Protocol (IP) suite of communications protocols and the principal communications protocol used for relaying datagrams (also known as network packets) across an internetwork.	2.1 Define Internet Protocol (IP) 2.2 Define IP network 2.3 Distinguish the IP hosts (servers and clients) 2.4 Define an IP address 2.5 Distinguish classful and classless IP addressing 2.6 Distinguish public and private IP addressing 2.7 Outline DHCP address assignment process

	2.8 Identify the World Regional Internet Registries 2.9 Describe IP subnetting and supernetting framework 2.10 Outline how the internet infrastructure works 2.11 Describe the history of the internet
3. The several basic concepts that surround the routing process and the concept of a route.	3.1 Outline the routing process 3.2 Analyse static routing configuration 3.3 Examine the routing table entries in Windows Operating System 3.4 Examine the route lookup process Windows Operating System 3.5 Define the concept of network renumbering 3.6 Outline the IP datagram structure 3.7 Describe unicast, broadcast and multicast 3.8 Demonstrate using Windows route command 3.9 Analyse the functions of a router 3.10 Outline routing, routed and non-routable protocols 3.11 Distinguish distance vector vs link state routing 3.12 Define CIDR notation
4. The basic functionality of a routing table, how routers work and what happens when data is transmitted from one router to another.	4.1 Identify how messages flow between networks 4.2 Analyse how network traffic is directed 4.3 Define how packets are transmitted 4.4 Analyse how routers configure the paths that packets take 4.5 Outline how packets are routed 4.6 Identify how routers know where to send data 4.7 Distinguish logical addresses from MAC addresses 4.8 Demonstrate using traceroute command 4.9 Describe denial of service attacks 4.10 Analyse the internet backbone
5. How algorithms aid the process of path determination and differences between algorithms that use static routes and dynamic routes.	5.1 Identify the functions of routing algorithm 5.2 Distinguish link-state and djikstra algorithm 5.3 Describe distance vector algorithms 5.4 Analyse hierarchical routing 5.5 Analyse routing in both Windows and Cisco routing environments 5.6 Describe routing terms 5.7 Analyse router routing process and associated problems 5.8 Analyse routing protocols foundations 5.9 Identify terms and addressing concepts in internetwork 5.10 Describe redundant IP routing 5.11 Analyse Windows operating system IP routing features 5.12 Describe end-to-end IP routing
6. How Routing Information Protocol (RIP) and Interior Gateway Routing Protocol (IGRP) supports multiple metrics provide the standard IGP protocol for local area networks, and network stability.	6.1 Describe RIP convergence behaviour 6.2 Distinguish RIPv1 and RIP v2 6.3 Describe RIP routing process 6.4 Outline IGRP characteristics 6.5 Analyse IGRP stability features 6.6 Analyse IGRP timers 6.7 Describe the differences between IGRP and RIP

7. Enhanced Interior Gateway Routing Protocol (EIGRP) characteristics and improvements over IGRP.	7.1 Examine and describe EIGRP metrics 7.2 Analyse the features of EIGRP 7.3 Identify how EIGRP works 7.4 Outline how EIGRP operates 7.5 Describe EIGRP message timers 7.6 Describe Diffusing Update Algorithm (DUAL)
8. The characteristics of Open Shortest Path First (OSPF) routing protocol compared to EIGRP.	8.1 Describe OSPF operation 8.2 Describe OSPF synchronisation process 8.3 Identify and describe OSPF areas 8.4 Identify OSPF operations in broadcast and non-broadcast networks 8.5 Describe OSPF virtual links 8.6 Analyse OSPF networks 8.7 Describe OSPF stub areas 8.8 Describe OSPF external routes 8.9 Demonstrate troubleshooting OSPF
9. Border Gateway Protocol (BGP) routing protocol characteristics and implementations.	9.1 Define BGP 9.2 Distinguish eBGP vs iBGP 9.3 Describe BGP AS numbers 9.4 Analyse BGP peering process 9.5 Outline BGP AS-Path attributes 9.6 Describe BGP finite states 9.7 Analyse BGP messages 9.8 Outline BGP path selection algorithm
Methods of Evaluation: A 2½-hour written examination paper with five essay questions, each carrying 20 marks. Candidates are required to answer all questions. Candidates also undertake project/coursework in IP Routing Technology with a weighting of 100%.	

Recommended Learning Resources: Internetwork Infrastructure

Text Books	• Cisco Routers for IP Routing by Innokenty Rudenko ISBN-10: 1576104214 • IP Routing Protocols - RIP, OSPF, BGP, PNNI & Cisco Routing Protocols by Uyless N. Black ISBN-10: 0130142484 • Operations and Management in IP-Based Networks by Petre Dini, Jürgen Schönwälder, Thomas Magedanz and Edmundo R.M. Madeira ISBN-10: 3540293566 • IP Network Design (Networking Series) by Cormac Long ISBN-10: 0072129999
Study Manuals 	BCE produced study packs
CD ROM 	Power-point slides
Software 	Windows Client and Server Operating System