COURSE NUMBER: CE3210

COURSE TITLE: Carrier Networks

COURSE DESCRIPTION:

This course provides the learner with an in depth understanding of how carrier transport networks operate at Layers 1 and 2. Learners will examine how traffic channels are constructed and the protocols used to manage the flow of traffic across a carrier network. Learners will combine theory with practical examples.

PREREQUISITES: CE2280 – Modulation & Encoding

CO-REQUISITES: None

CREDIT VALUE: Four (4)

COURSE HOURS PER WEEK: Three (3)

LAB HOURS PER WEEK: Two (2)

SUGGESTED TEXT: To be determined by instructor

LEARNING RESOURCES: To be determined by instructor

MAJOR TOPICS:

1.0 Multiplexing Techniques
2.0 Digital Transmission
3.0 Integrated Services Digital Networks (ISDN)
4.0 Synchronous Optical Network (SONET) and Synchronous Digital Hierarchy (SDH)
5.0 Asynchronous Transfer Mode (ATM) Technologies
6.0 Frame Relay Technology

LEARNING OBJECTIVES:

The expected learning outcomes are that the learner will be able to:

1.0 Multiplexing Techniques

1.1 Introduction to Multiplexing
- 1.1.1 Differentiate between Time-Division Multiplexing (TDM) and Frequency Division Multiplexing (FDM)
- 1.1.2 Explain TDM utilizing illustrations

1.1.3 Explain FDM utilizing illustrations

1.2 Time-Division Multiplexing
- 1.2.1 Describe the organization of TDM networks in North America
- 1.2.2 Differentiate between synchronous and asynchronous TDM networks
- 1.2.3 Describe the digital signal levels as defined by the North American hierarchy
- 1.2.4 Explain the effects of improperly timed networks
- 1.2.5 Describe the timing hierarchy for TDM networks

1.3 Digital Signal 1 (DS-1/T1)
- 1.3.1 Explain the digital signal 0 (DS-0) channel
- 1.3.2 Explain the composition of DS-1 (T1)
- 1.3.3 Differentiate amongst different DS-1 (T1) frame formats
- 1.3.4 Explain Channel Associated Signaling (CAS)
- 1.3.5 Confirm the frequency range of a DS-1 (T1)
- 1.3.6 Select media suitable for use with DS-1

1.4 Digital Signal 3 (DS-3/T3)
- 1.4.1 Explain why only certain media are suitable for DS-3
- 1.4.2 Differentiate between the frame formats used with DS-3
- 1.4.3 Describe the signal characteristics of a DS-3
- 1.4.4 Discuss the advantages/disadvantages of the T1/T3 carrier systems relative to each other

1.5 European-Carrier (E-Carrier) Networks
- 1.5.1 Differentiate between the E-Carrier system and the North American system
- 1.5.2 Differentiate between E-1 and E-3

2.0 Digital Transmission

2.1 Asynchronous and Synchronous Transmission
- 2.1.1 Compare asynchronous and synchronous transmission in terms of methods to achieve synchronization

2.2 Modems
- 2.2.1 Explain the purpose of modems
- 2.2.2 Explain the operations of modems
- 2.2.3 Differentiate between modems according to speed and application
- 2.2.4 Evaluate modem performance in a specified application
- 2.2.5 Compare modems for use with Digital Subscriber Line (xDSL) including
  - 2.2.5.1 RADSL
  - 2.2.5.2 ADSL
  - 2.2.5.3 SDSL
  - 2.2.5.4 HDSL

2.2.5.5 VDSL

2.2.6 Compare modems for use with Cable Television (CATV) broadband networks, including
2.2.6.1 Data Over Cable Service Interface Specification (DOCSIS)
2.2.6.2 Cable Modem Termination System (CMTS)

2.3 High Level Data Link and Derived Protocols
2.3.1 Discuss Synchronous HDLC frame structure
2.3.2 Describe, including the use of illustrations, HDLC zero insertion/deletion process (bit stuffing)
2.3.3 Explain HDLC protocol point-to-point and multipoint (multidrop) data links
2.3.4 Compare HDLC modes including NRM, ARM, and ABM
2.3.5 Explain HDLC protocol data and control messages
2.3.6 Describe the format and purpose of HDLC U-frames, S-frames, and I-frames

2.4 Flow and Error Control in LANs
2.4.1 Describe, including the use of illustrations, top-and-Wait flow control
2.4.2 Discuss and illustrate Sliding Window Flow Control
2.4.3 Describe Automatic Repeat Request (ARQ) Error Control
2.4.4 Describe, including the use of illustrations, the Sliding Window ARQ
2.4.5 Describe, including the use of illustrations, the Sliding Window Go-Back ARQ routine
2.4.6 Describe, including the use of illustrations, the Acknowledgement (ACK) process
2.4.7 Describe, including the use of illustrations, the Negative Acknowledgement (NAK) process
2.4.8 Discuss the Forward-Error Correction (FEC) block

3.0 Integrated Services Digital Networks (ISDN)

3.1 ISDN Services
3.1.1 Compare the services provided using ISDN vs. POTS
3.1.2 Compare ISDN channels in BRI and PRI services

3.2 Characteristics of ISDN interconnect
3.2.1 Describe the overall architecture of an ISDN
3.2.2 Draw the reference diagram for ISDN Interfaces indicating components and reference points
3.2.3 Compare the functions of the following ISDN BRI components
3.2.3.1 NT1
3.2.3.2 NT2
3.2.3.3 TA
3.2.3.4 TE1

3.2.3.5 TE2

3.2.4 Compare the roles of the R, S, T, and U reference points for ISDN BRI
3.2.5 Describe the basic operation of Q.921 in layer 2 signaling for ISDN
3.2.6 Describe the basic operation of Q.931 in layer 3 signaling for ISDN

3.3 ISDN Configuration
- 3.3.1 Recognize common ISDN switch types
- 3.3.2 Describe the purpose of SPIDs
- 3.3.3 Configure a customer end ISDN BRI TE1 device
- 3.3.4 Configure a customer end ISDN PRI device
- 3.3.5 Analyze Q.921 signaling during the physical connection of the ISDN circuit to the TE1 device

3.4 ISDN end-to-end circuit-switched connection
- 3.4.1 Establish an end to end connection between two TE1 devices using an ISDN BRI
- 3.4.2 Establish an end to end connection between two devices using an ISDN PRI
- 3.4.3 Establish an end to end bonded connection between two devices using an ISDN PRI to obtain an Nx64kbps connection
- 3.4.4 Analyze the Q.931 signaling during connection establishment and tear-down

4.0 Synchronous Optical Network (SONET) and Synchronous Digital Hierarchy (SDH)

4.1 Describe the structure of SONET
4.2 Differentiate between SONET interfaces in terms of data rate and channels
4.3 Differentiate between Embedded Channel (EC) and Synchronous Transport Signal (STS)
4.4 Describe the STS-1 frame
4.5 Explain the relationship between Virtual Tributaries (VT) and STS
4.6 Describe SONET network architectures
4.7 Illustrate SONET operation for a given network architecture
4.8 Differentiate between SONET and SDH

5.0 Asynchronous Transfer Mode (ATM) Technologies

5.1 Introduction to ATM
- 5.1.1 Describe the architecture of an ATM network
- 5.1.2 Compare the ATM Cell Relay to Frame Relay
- 5.1.3 Discuss the advantages and disadvantages of ATM
- 5.1.4 Identify the ATM network interfaces
- 5.1.5 Explain the function and operation of each ATM interface
- 5.1.6 Explain ATMs use of multiplexing
- 5.1.7 Describe the components of an ATM transmission path

5.1.8 Differentiate between Virtual Circuits and Virtual Paths

5.2 ATM Protocol Reference Model
- 5.2.1 Explain the ATM Protocol Reference Model
- 5.2.2 Explain the purpose of the following:
  - 5.2.2.1 ATM Physical Layer
  - 5.2.2.2 ATM Layer
  - 5.2.2.3 ATM Adaptation Layer (AAL)
- 5.2.3 Explain operation of the following
  - 5.2.3.1 ATM Physical Layer
  - 5.2.3.2 ATM Layer
  - 5.2.3.3 ATM Adaptation Layer (AAL)
- 5.2.4 Differentiate between Layers and Planes
- 5.2.5 Describe the components and sub-layers of the AAL
- 5.2.6 Explain the purpose of each component of the AAL

5.3 ATM Addressing and Signaling
- 5.3.1 Explain the ATM address structure
- 5.3.2 Explain the purpose of signaling in an ATM network
- 5.3.3 Differentiate between types of ATM signals
- 5.3.4 Describe the ATM signaling protocol stack

6.0 Frame Relay Technology

6.1 Principles of Frame Relay
- 6.1.1 Describe the operation of Frame Relay
- 6.1.2 Discuss the advantages and disadvantages of Frame Relay
- 6.1.3 Compare Frame Relay to other carrier services

6.2 Frame Relay Virtual Circuits
- 6.2.1 Differentiate between a virtual circuit and a physical circuit
- 6.2.2 Differentiate between switched virtual circuits (SVC) and permanent virtual circuits (PVC)
- 6.2.3 Explain the operational stages of a SVC
- 6.2.4 Explain the purpose of the Data-Link Connection Identifier (DLCI)

6.3 Frame Relay Devices
- 6.3.1 Identify the components of a Frame Relay network
- 6.3.2 Differentiate between customer premises equipment and service provider equipment
- 6.3.3 Explain how the customer network accesses the Frame Relay network

6.4 Frame Relay Management
- 6.4.1 Describe the Frame Relay frame

6.4.2 Explain the function of each field in a Frame Relay frame
6.4.3 Explain Frame Relay congestion control
6.4.4 Explain the purpose of the Local Management Interface (LMI)
6.4.5 Troubleshoot Frame Relay issues associated with LMI types
6.4.6 Confirm Frame Relay operation using appropriate device commands

EVALUATION:

Laboratories	15 %
Assignments	15 %
Tests	30 %
Final Exam	40 %

DATE DEVELOPED: March 2012 **DATE REVIEWED:**

REVISION NUMBER: **DATE REVISED:**

Note to instructor: Check PIRS to ensure this outline is the most current version.