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learntelecoms interactive e-learning suite of courses:
SyncNet v6—SDH-based broadband networks

SyncNet

- is a suite of interactive, multimedia e-learning courses designed to run under Windows™ 98, 2000 Professional, XP or Vista.
- provides training in the technical aspects of SDH-based broadband networks.
- consists of six separate but integrated courses:

A: Transmission principles
B: SDH principles
C: Optical line systems inc WDM
D: SDH payloads
E: SDH networks
F: SDH network management and maintenance

Each SyncNet course:

- provides several hours of in-depth, authoritative technical training
- employs interactive simulations, hypertext links and question sessions to fully involve the trainee in the learning experience.
- provides personalised training with each trainee able to make his/her on notes and place bookmarks. A record of progress and level of achievement is recorded for each trainee.
- provides a structured assessed course and can also be used to browse for revision or reference.
- can be studied in isolation or as an integrated suite; each chapter of a course includes revision
- links to relevant subjects covered in the other SyncNet courses.

Target audience:

SyncNet is designed for:

- Those studying for a career in telecommunications and who require a detailed knowledge of modern optical broadband transmission networks.
- Technical staff involved in the operation, installation or maintenance of SDH-based broad band networks.

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learntelecoms interactive e-learning suite of courses:
Course A: Transmission principles

Course aim:

This course provides an introduction to the fundamental concepts that underpin the operation of synchronous transmission networks.

Pre-requisites:

Secondary (high) school education in Physics and/or general electronics/electrical engineering background.

In the UK, appropriate pre-requisite qualifications are General Certificate of Secondary Education (GCSE) in Physics or BTEC National Vocational Qualification (NVQ) at level 2 in Electronics.

Course content:

Bits and bytes: Significance of bits, bytes and bit rate; introduction to the principles of digital encoding of text, graphics and speech; typical bandwidth requirements of various types of media.

Transmission modes: Principles of asynchronous and synchronous transmission and comparison of these transmission modes; transport of asynchronously generated traffic over a synchronous link.

TDM multiplexing: Principles of Time Division Multiplexing (TDM) and byte interleaving; principles of frame alignment; description of the role of a primary multiplexer; functional description of typical primary multiplexer cards.

2 Mbit/s frame structure: Basic frame structure of a 2 Mbit/s synchronous signal conforming with ITU-T recommendations; derivation of the repetition rate of a 2 Mbit/s frame; principles and use of timeslot interchange; role and basic operation of different types of primary multiplexer and synchronous equipment including terminal multiplexers, Drop and Insert multiplexers and 2 Mbit/s cross-connect equipment.

Synchronisation: Principles of synchronisation and timing distribution; effects of inadequate timing control; hierarchical distribution of timing; required timing stability of primary and secondary timing sources; extracting timing from a received signal.
Jitter: Definition of jitter; causes and effects of jitter; minimising jitter: the role and principles of justification.

Transmission networks: Summary of the main components and purpose of a transmission network; introduction to the Plesiochronous Digital Hierarchy (PDH); comparison of North American and European versions of the PDH; Synchronous Digital Hierarchy (SDH) and SONET signals; basic structure of an SDH-based transmission network.

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learntelecoms interactive e-learning suite of courses:
Course B: SDH principles

Course aim:

After completing this course a trainee will be able to describe the benefits, features and basic principles of the Synchronous Digital Hierarchy (SDH).

Pre-requisites:

Understanding of the basic principles of synchronous transmission; knowledge of PDH transmission networks would also be advantageous. It is recommended that SyncNet course A: “Transmission principles” or StarTel courses A and C (“Fundamentals of Telecoms” and “Telecoms networks”) are studied before attempting this course.

Course content:

Overview of SDH: Aims of the ITU when drawing up recommendations for equipments and networks based on the Synchronous Digital Hierarchy (SDH); advantages of employing a network based on the SDH; typical uses of networks based on the SDH.

Capabilities of SDH networks: Properties of SDH aggregate signals including the ITU recommended bit rates and payload capabilities, traffic payload capabilities and maximum distances between regenerators; capabilities and typical uses of different types of SDH network element including terminal multiplexers and drop and insert multiplexers.

Optical links: The basic components of an optical link; purpose of ITU recommendations relating to optical interfaces between transmission equipment.

SDH Management: Overview of facilities of an SDH network management system in terms of configuration management, fault and maintenance management, performance monitoring and security management.

SDH payloads: Introduction to the concepts of virtual containers, tributary units and tributary unit groups; principles of using virtual containers to transport different types of traffic within an STM signal; payload capabilities of the various types of virtual container.

STM-1 frame: Basic functions of an STM-1 multiplexer; description of the basic structure of the STM-1frame including the number and location of payload and overhead bytes and an explanation of the standard (ITU-T) method of representing the frame structure.

Section overheads (SOH): Overview of the purpose of the Section Overhead (SOH) bytes in an STM-1 frame in terms of frame alignment, error checking, data communications; orderwire provision and provision of automatic protection switching; comparison of the roles of the regenerator section overhead (RSOH) and the multiplex section overhead (MSOH) bytes; purpose of the individual bytes of the SOH.

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learntelecoms interactive e-learning suite of courses:
Course B: SDH principles

Payload pointers: Cause of phase variation between an STM frame and its payload; structure of a virtual container in terms of Path Overhead (POH) and payload container; locating the POH of a virtual container by use of the pointer bytes in an STM frame.

Payload mapping: The location of a VC-4's pointer in the Section Overhead (SOH) of an STM-1 frame; the concept of carrying virtual containers within a larger virtual container; the structure of a Tributary Unit (TU) in terms of a virtual container and its pointer; the relationship between TUs and Tributary Unit Groups (TUGs).

STM-n frames: Use of byte interleaving to multiplex STM-1signals to form STM-n aggregate signals with n equal to 4, 16 or 64; description of the frame structure of STM-n signals; purpose of the A1, A2 and J0 bytes of the Section Overhead of an STM-4 frame; comparison of direct and indirect multiplexing to produce an STM-16 aggregate signal; concept and purpose of concatenation; principles, use, and comparison of explicit and virtual concatenation.

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learntelecoms interactive e-learning suite of courses:
Course C: Optical line systems

Course aim:

After completing this course a trainee will be able to describe the characteristics, operation and use of the main functional components of optical line systems conforming to the ITU recommendations relating to the Synchronous Digital Hierarchy (SDH).

Pre-requisites:

Understanding of the basic principles of synchronous transmission and the principles of the SDH. It is recommended that SyncNet course A: “Transmission principles” and SyncNet course B: “Principles of SDH” is studied before attempting this course.

Course content:

Optical fibre principles: Overview of the electromagnetic spectrum; advantages of using infrared energy to carry digital information over an optical fibre; basic structure of an optical fibre; definition and significance of acceptance angle; properties of optical sources that are suitable for use in optical transmission systems.

Dispersion: Explanation of the concept of dispersion; effects of dispersion in optical fibre including the limitation on maximum bit rate; causes of dispersion including modal dispersion and chromatic dispersion.

Optical loss: Principles and effects of scattering, absorption, connector and bending loss in optical fibre; the minimum loss window: loss characteristics of medium and high quality optical fibre; effect of water ions on the loss of optical fibre.

Fibre types: Structure, capabilities and typical applications of multimode fibre, single-mode fibre and graded index fibre; principles, characteristics and applications of Dispersion Free Fibre, Dispersion Shifted Fibre and Non-Zero Dispersion Shifted Fibre.

Optical line systems: Role and functional description of Optical Line Terminal Equipment (OLTE) and regenerators; principles of an optical amplification; advantages of the use of optical amplifiers; use of optical amplifiers as repeaters, power boosters and pre-amplifiers; principles of bi-directional optical amplification.

Optical interfaces: Characteristics of STM-1 to STM-256 optical interfaces as recommended by the ITU for SDH networks: types of fibre, their specifications and recommended optical wavelengths for different lengths of unregenerated optical links; optical safety and hazard levels

Power budgeting: Explanation of the concepts and relevance of system margin, launched power, dispersion penalty, cable loss and receiver sensitivity; description of a method of calculating the maximum optical loss that can be tolerated for a particular link.

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learntelecoms interactive e-learning suite of courses:
Course C: Optical line systems

SDH terminal multiplexers: Description of the functions, layout and capabilities of typical STM-1, STM-4, STM-16 and STM-64 terminal multiplex equipment.

WDM: Principles of Wavelength Division Multiplexing (WDM); components of a WDM system; bi-directional operation using WDM; description and comparison of wideband WDM, narrowband WDM, Coarse WDM (CWDM) and Dense WDM (DWDM); comparison of the different methods of increasing the capacity of existing systems; causes and effects of optical impairments including chromatic dispersion and optical non-linearity; use of Dispersion Shifted fibre and dispersion compensation; optical safety of WDM systems.

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learntelecoms interactive e-learning suite of courses:
Course D: SDH payloads

Course aim:

After completing this course a trainee will be able to describe how different types of traffic are transported over an SDH network. The roleand significance of Tributary Units is discussed and the methods of carrying plesiochronous, synchronous and asynchronous traffic described. The role of the different types of SDH overhead is also explained.

Pre-requisites:

Understanding of the principles of the SDH and an understanding of the principles of packet switching including ATM and the Internet Protocol (IP); knowledge of the principles and components of an Ethernet LAN would also be advantageous. It is recommended that SyncNet course B: “Principles of SDH”, TransNet course D “ATM principles”, and the LanNet courses A and B (“Ethernet fundamentals” and “Ethernet networks”) are studied before attempting this course.

Course content:

AU payloads: Transporting a 140 Mbit/s signal within a STM-1 frame; revision of the concept of virtual containers; structure of a VC-4; concept of an Administrative Unit (AU); operation and use of an AU pointer; role and operation of byte justification.

TU payloads: Mapping 34 Mbit/s signals into an STM-1 frame; structure of a VC-3; overview of the concept of Tributary Units (TU); transporting VC-3s within a VC-4; operation and use of TU pointers.

TUG payload: Concept of a Tributary Unit Group (TUG); the different types of TUG and their payload capacity; description of the use of TU-12s, TUG-2s and TUG-3s to map up to sixty-three 2 Mbit/s signals into a single 155 Mbit/s STM-1 frame; transporting groups of CEPT and ANSI signals within the same STM-1 frame; asynchronous and byte synchronous 2 Mbit/s (VC-12) payloads; comparison of the locked and unlocked configurations of byte synchronous operation.

Path overhead (POH): Review of the role of Section Overheads (SOH) of an STM frame; role of the Path Overhead (POH) of a Virtual Container (VC); comparison of the roles of Multiplex Section Overhead (MSOH), Regenerator Section Overhead (RSOH) and POH; structure of the POH in higher-order and lower-order VCs and function of the individual POH bytes.

ATM over SDH: Sharing the bandwidth of an SDH-based optical link with different types of traffic; overview of the benefits of the Asynchronous Transfer Mode (ATM); basic structure of an ATM cell; interfacing ATM switches with SDH multiplex equipment; mapping ATM cells into a VC-4 virtual container of an STM-1 frame; role of the Transmission Convergence (TC) ATM protocol; function of those STM section and path overheads used by ATM equipment.

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learntelecoms interactive e-learning suite of courses:
Course D: SDH payloads

IP over SDH: Overview of the use of ATM virtual circuits to provide a differentiated quality of service for IP traffic; transporting IP traffic over an SDH network without the use of ATM; functions and operation of the Point to Point Protocol (PPP); mapping PPP frames into a VC-4 STM virtual container; comparison of the benefits of the use of ATM and PPP; overview of the use of Wavelength Division Multiplexing (WDM) to transport IP traffic over an optical network.

Ethernet over SDH: The disadvantages of the use of PPP; introduction to the Generic Framing Procedure (GFP) and its use in interconnecting Ethernet Local Area Networks; principles and advantages of virtual concatenation; role and principles of the Link Capacity Adjustment Scheme (LCAS); summary and comparison of the various methods of transporting IP traffic over an SDH network.

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learntelecoms interactive e-learning suite of courses:
Course E: SDH networks

Course aim:

After completing this course a trainee will be able to describe the main components, structure and capabilities of networks conforming to the ITU recommendations relating to the Synchronous Digital Hierarchy (SDH) including all-optical networks.

Pre-requisites:

Understanding of the principles of the SDH, the principles of optical fibre and the principles of virtual containers. It is recommended that SyncNet course B: “Principles of SDH”, SyncNet course C: “Optical line systems” and SyncNet course D: “SDH payloads” are studied before attempting this course.

Course content:

SDH network elements: Overview of the different modes of operation of SDH multiplex equipment including Drop and Insert, Drop and Continue, hairpinning and terminal mux; functions and capabilities of typical SDH Drop and Insert multiplex equipment; provision of line and tributary protection; role of hubbing multiplexers, role and capabilities of SDH cross-connect equipment.

Synchronisation hierarchy: The need for a single traceable timing source in a synchronous network; provision of timing diversity in case of link or equipment failure; the role and characteristics of Primary and Secondary Reference Clocks (PRC and SRC) in a hierarchical timing distribution network; alternative structures for the timing distribution network; the use of the Global Positioning System (GPS) as a PRC; synchronisation issues when interconnecting SDH networks.

Timing distribution: Methods of distributing timing information over a network: dedicated timing links; extracting timing from a received optical signal; the role and limitations of the internal clock of a multiplexer; extracting timing from a tributary signal; importance of the traceability of a timing source; effects of jitter on the stability of a timing signal; effects of incorrect timing.

STM-1 rings: The provision of traffic paths over a system consisting of interconnected Drop and Insert Mux equipment; advantages of a ring network; structure, components and features of an STM-1 ring network; interconnecting STM-1 rings.

STM-4 rings: structure, components and features of an STM-4 ring network; interconnecting STM-4 rings; interconnecting STM-4 and STM-1 rings; explanation and comparison of Tributary Unit (TU) and Administrative Unit (AU) cross-connecting.

Protection schemes: The requirement for an Automatic Protection System (APS); principles and benefits of the different methods of protecting traffic in the event of line or equipment failure including end-to-end path protection, sub-network connection protection, Multiplex Section protection and span protection.

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learntelecoms interactive e-learning suite of courses:
Course E: SDH networks

Network architectures: The requirement for a resilient but flexible network structure; classification of networks in terms of national, regional and local distribution; provision of distributed cross-connect functionality using interconnected ring sub-networks; capabilities and use of dedicated SDH cross-connect equipment; benefits of mesh network structure.

Network interconnection: Issues relating to interconnecting networks operated by different organisations; definition and comparison of Customer sited, In-building and In-span interconnection; management and synchronisation issues relating to the different interconnect methods; the use of equipment “hotels”.

Optical Transport Networks (OTN): Benefits of an all-optical network; principles of a MOEMS optical cross-connect; basic components of an all-optical network including optical add/drop multiplexers and cross-connect equipment; structure and capabilities of an Optical Transport Network (OTN); concepts of Optical channel Transport Units (OTU) and Optical Transport Modules (OTM); provision and features of supervisory channels in an OTN.

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learntelecoms interactive e-learning suite of courses:
Course F: SDH network management and maintenance

Course aim:

After completing this course a trainee will be able to describe the structure and use of an integrated network management system and discuss maintenance issues.

Pre-requisites:

Understanding of the principles of the SDH and the basic structure and components of an SDH network. It is recommended that SyncNet course B: “Principles of SDH”, and SyncNet course E: “SDH networks” are studied before attempting this course.

Course content:

Network management user interfaces: Typical facilities offered to users of a Network Management System (NMS) in terms of configuration management, fault and maintenance management, monitoring performance and security management.

NMS data links: Review of the role of the Path Overhead (POH), Multiplex Section Overhead (MSOH) and Regenerator Section Overhead (RSOH); use of the POH, MSOH and RSOH to locate faults; provision and use by Network Management System (NMS) of Embedded Communication Channels.

Structure of a TMN: Role of a Telecoms Management Network (TMN); a TMN’s hierarchical view of a managed system in terms of network, sub-network, network element and managed object; components of a TMN: role of Network Elements; Gateway Network Elements (GNE), Mediation function and Operations System (OS).

Emulation of NMS: a simulation demonstrates the facilities of a typical Network Management System (NMS).

Network maintenance: objectives of a network maintenance regime with reference to system commissioning and performance monitoring; types, capabilities and use of test equipment required to carry out line, network element, link and path tests.

Alarm indicators: Functions of the section and path overhead alarm indicators; meaning, significance and relationship between a Remote Error Indication (REI), a Remote Defect Indication (RDI) and an Alarm Indication Signal (AIS); using alarm indicators to locate a fault.

SDH testers: Typical features and capabilities of SDH test equipment; use of SDH test equipment for commissioning and fault-finding purposes.