

National Teaching Programme for the Technical Degree (DUT)

"Networks and Telecommunications" specialisation

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1 PREAMBLE

Working within the European LMD (1st degree/Masters/Doctorate) structure, Networks and Telecommunications Departments deliver a course framework which aims to prepare students over 2 years for the role of 'advanced technician', whilst providing the opportunity to continue their studies on the basis of the Personal Vocational Project they will have completed throughout the course.

2 GENERAL INTRODUCTION TO THE COURSE

2.1 Targeted occupational and technological skills

A DUT graduate will be able to take on a variety of different roles, which can progress towards leadership of small teams or customer interface type jobs. The tasks which an 'advanced technician' can perform include:

- analysing or drawing up specifications,
 - developing or selecting technical solutions (hardware and software) and products, whilst incorporating reliability and quality considerations,
 - project leadership for medium-sized projects,
 - installation, configuration, maintenance and repair of equipment,
 - leading a small team,
 - acting as their company's representative in dealings with customers.
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Networks & Telecommunications DUT graduates are able:

- to understand the principles and optimise the operation of a network, including the major protocols used (both standardised and non-standardised),
- to participate in drawing up specifications and contribute to drawing up the topology for a network or a telecommunications installation, to manage and upgrade such installations by choosing the appropriate equipment and software,
- to install and configure all the component parts: cables, aerials, connectors, wireless transmission systems (aerials, decoders, etc.), as well as to perform validations,
- to install and configure the component parts of a telecommunications channel (bridges, switchers, routers, autoswitches, etc.),
- to install and configure the hardware and software for telecommunications systems and networks,
- to maintain and upgrade a configuration in accordance with needs assessments and with the development of the technology, economic indicators, etc.,
- to set up and use computer equipment working on conventional operation systems,
- to be familiar with, install, maintain and take part in the development of the software and applications distributed,
- to implement a network security policy,
- to be familiar with the basics of the law relating to IT and the Internet.

2.2 Jobs and industry sectors

The types of profession which the course aims at are those involving the installation, management and maintenance of all types of network, the application environments which use them and administration of the operating systems. This covers all kinds of network: traditional IT networks, telephone networks, integrated service networks, mobile networks, etc.

"Networks and Telecommunications" graduates can consider posts as:

- Systems and Networks administrators,
- Operations managers,
- Network and ICT Systems architects,
- Software and hardware maintenance managers for networks and/or telecommunications installations.

There are currently many openings for these positions in:

- service companies and network equipment manufacturers,
- telecommunications carriers and Internet access providers,
- companies and bodies which manage their own information and communication systems,
- telephone system installers,
- IT engineering and service companies.

2.3 Involvement of industry professionals

Professionals participate in the life of the departments through a number of different activities: presenting careers in the field within the context of the Personal Vocational Project, taking part in sessions of the admission panel, Diploma awarding panel, research and course monitoring panels and collaborating on projects. They play a direct role in the teaching, their optimum involvement being 20% of the timetable and in all circumstances at least 10%.

To achieve this, it is recommended that mixed teams of teaching staff and professionals are set up so that they can define teaching goals and processes together. This means that even if they only have a few hours' contact time with the students, they can provide valuable input to the team by taking part in initial discussions, presentation of subjects and results assessment sessions.

3 THE COURSE

3.1 Description of the course content

This course is structured around a skills core which is equivalent to 80% of the overall course and is supplemented by modules which the student chooses according to the vocational direction they wish to take. The teaching, which is organised in modules and spread over four teaching units, is delivered on a semesterly basis.

The course curriculum leading to the DUT consists of one major, covering the core skills for the DUT, plus supplementary modules. These supplementary modules are designed to provide a complete programme for students, whether they are looking to go straight into employment or to continue their higher education training with other courses.

3.2 Workplace training, tutored and personal projects

3.2.1 Workplace training in the industry

The workplace training, which lasts a minimum of 10 weeks, is intended as an introduction to the reality of employment in the industry. Any students who are intending to go straight into employment can plan to extend their training by 4 weeks, which will be given the same weight in assessment as two supplementary modules.

It takes place preferably during the fourth semester and is flexible in the way it is organised, to allow for all the different possible variations (international exchanges, preparation period for the training, etc.). The department oversees monitoring and supervision during the workplace training, notably by means of visits to the host companies.

A report is produced after the training, as well as a viva voce assessment in front of a panel of teaching staff and professional workplace tutors.

3.2.2 Tutored project

The aim of the tutored project is to enable the student to develop independence. The theme of the project can be supplied by the project tutor, a company or a local council. The subject is often a study which relates to disciplines within the specialist area, though this is not obligatory.

The project should develop:

- an understanding of project leadership methodology (group work, time management, meeting deadlines, drawing up a works specification, etc.),
 - the ability to put knowledge and skills into practice (documentary research, suggesting solutions, producing reports, etc.).
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3.2.3 Personal Vocational Project

The Personal Vocational Project (PPP) is an in-depth piece of work which aims to enable students to gain an accurate picture of Networks and Telecommunications professions and what they require in the way of personal skills. It should guide students towards tailoring their personal aspirations in order to plan a training programme suited to the occupation chosen. The Personal Vocational Project is based on individual tutoring by a member of the teaching staff.

At the end of the course, each student will be better acquainted with the various jobs within the industry, the job market, and the vocational and tertiary courses available. The Project allows each student to identify their own vocational motivation, personal qualities and skills. Each institution will have different ways of approaching the project (relationships with former students, outside involvement, logbooks, visits to companies, forums, talks, interviews, workshops, etc.).

4 STRUCTURE

4.1 Overall framework

The training delivered is divided into 4 teaching units (UEs).

- UE1: Science and foundation studies: Maths, Physics, Culture & Communication, Business awareness and English
- UE2: Information technology and Electronics
- UE3: Telecommunications and Networks
- UE4: Vocational projects: tutored project and workplace training.

4.2 Course content in numbers of hours

Teaching (hours)	S1	S2	S3	S4	Total
<i>Core Skills</i>					
UE1: Science and foundation studies	210	180	180		570
UE2: IT and Electronics	180	150	120		450
UE3: Telecommunications and Networks	120	180	180		480
UE4: Vocational Projects					
<i>Supplementary Modules</i>					
Spread over the teaching units depending on the options chosen			30	270	300
Total	510	510	510	270	1800

4.3 List of modules and distribution

Overall composition of the course

40 core skills modules + 10 supplementary modules + tutored project + workplace training.

Distribution of timetable

1020 hours (34 weeks) over the first two semesters, 780 hours over semesters 3 and 4 (26 weeks).

4.3.1 1st Semester

UE11: Science and foundation studies (FSH)			
			no. of hours
Maths			90

Culture & Communication		30
English		45
Alternative learning / Personal Vocational Project		45
UE11 total		210
UE12: IT and Electronics		
IT		90
Electronics		90
UE12 total		180
UE13: Telecommunications and Networks		
Telecommunications		60
Networks		60
UE13 total		120
S1 total		510

4.3.2 2nd Semester

UE21: Science and foundation studies (FSH)		
		no. of hours
Maths		60
Physics		30
Culture & Communication		30
English		45
Personal Vocational Project		15
UE21 total		180
UE22: IT and Electronics		
IT		90
Electronics		30
Alternative learning		30
UE22 total		150
UE23: Telecommunications and Networks		
Telecommunications		90
Networks		90

UE23 total		180
S2 total		510

4.3.3 3rd Semester

UE31: Science and foundation studies (FSH)		
		no. of hours
Maths		30
Physics		30
Culture & Communication		45
English		30
Business awareness		30
Personal Vocational Project		15
UE31 (core skills)		180
UE32: IT and Electronics		
IT		60
Electronics		60
UE32 total (core skills)		120
UE33: Telecommunications and Networks		
Telecommunications - Networks		180
UE33 total (core skills)		180
Supplementary module		30
S3 total		510

4.3.4 4th Semester

UE41: Science and foundation studies (FSH)		
		no. of hours
Supplementary modules: between 2 and 6		between 60 and 180 hrs
UE42: IT and Electronics		
Supplementary modules: between 2 and 6		between 60 and 180 hrs
UE43: Telecommunications and Networks		
Supplementary modules: between 2 and 6		between 60 and 180 hrs
UE44: Vocational Projects		

	Tutored project (no. of non-contact hours)	(300 hrs)
	Workplace training	(10 to 12 weeks)
S4 total for 9 supplementary modules		270

4.4 Option paths

During the course of the 3rd and 4th semesters, students choose 10 supplementary 30-hour modules. The course teams assist students in their choice, which should be based on their Personal Vocational Project. The supplementary modules cover three different categories [(AT: *Approfondissement Technologique (in-depth technology study)*), RCP: *Renforcement des Compétences Professionnelles (reinforcing occupational skills)*] and OS: *Ouverture Scientifique (Scientific Openness)*]. The supplementary modules work together either to better prepare for employment at level III [*IP: Insertion Professionnelle (going into employment)*], to prepare for progression to a level II qualification [*LP: Licence Professionnelle (Professional Degree)*], or to prepare for further study towards a level I qualification [*PE: Poursuite d'Etudes (Further Studies)*].

The list of supplementary modules set out in paragraph 5.4 is not exhaustive and can be added to, to take account of local factors and the training offered by the university of affiliation or other institutions, in order to promote any possible links. The second table classifies the modules according to type of career path and skills. In order to allow each establishment more flexibility, each option path may be made up of different module types (OS, AT or RCP).

5 COURSE CONTENT SHEETS

5.1 1st Semester

Networks and Telecommunications DUT

M1

Fundamentals of algebra and trigonometry

Teaching unit: UE1, Science and foundation studies

Subject: Maths

No of hours: 30 hours Teaching=10hrs/directed work=15hrs/hands-on=5hrs

Semester: S1/S2

Targets:

- To be familiar with complex numbers and the complex plane within the field of algebra,
- To be able to identify rational functions and master the associated algebra calculations.

Minimum skills acquired:

The ability to:

- master all types of calculations and graphic representations, using the complex exponential,
- manipulate trigonometry formulae,
- solve algebra equations of a degree lower than or equal to 4, with real coefficients
- decompose a rational function into simple real elements, such as:

$$\frac{A}{x - a} \quad \frac{A}{(x - a)^2} \quad \frac{A x + B}{a x^2 + b x + c} \text{ (irreducible denominator)}$$

Previous study required: 'STI' high school final year curriculum

Content:

- Elements of plane geometry
- Complex numbers (modulus, argument, square roots, cube roots)
- Trigonometry and trigonometry functions
- Trigonometry formulae (eg: $a \cos \omega t + b \sin \omega t$ transform)
- Defining the reciprocal functions of trigonometric functions
- Factorising polynomials of low degree
- Equations of degree two with complex coefficients
- Decomposition of rational functions into simple elements

Possible extensions:

- n^{th} roots
- Transforms in the complex plane (Bode, Nyquist, etc)
- Bijection principle
- Error-correcting codes

Suggested teaching methods:

The subjects in this module can be put to use to construct various kinds of reasoning (reductio ad absurdum, contrapositive, induction, counter example ...)

Keywords: Phase, Arctangent, Amplitude.

Networks and Telecommunications DUT

M2

Fundamentals of Analysis

Teaching unit: UE1, Science and foundation studies

Subject: Maths

No of hours: 30 hours Teaching=10hrs/ directed work =15hrs/hands-on=5hrs

Semester: S1/S2

Targets:

- To familiarise students with the functional model,
- To understand the geometric meaning of a differential equation,
- To understand the definition of the Riemann integral (continuous functions on intervals).

Minimum skills acquired:

The ability to:

- create a graphic representation of a given function,
- write the expression of a given type of function when it is defined by its graphic representation,
- recognise the geometric meaning of a given function's properties,
- calculate the derivative of a composite function comprising ordinary functions
- use the properties of the integral with ease.

Previous study acquired: 'STI' high school final year curriculum

Content:

- Continuous functions on intervals, parity, odd parity
- Periodicity (period, pulsation, frequency)
- Signal modelling (square wave, triangular wave)
- Leads, delays, rectifying, scale changing
- Non-differentiable functions
- Derivative of a composite function
- Complements of functions ($\ln x$, $\log x$, $\log_2 x$, e^x , a^x)
- Properties of reciprocal trigonometric functions
- Definition of the Riemann integral (continuous functions on intervals)
- Properties of integrals

Possible extensions:

- Numerical approximation of integrals,
- Optimisation,
- Limits and equivalentents,
- Limited expansions,
- Link between integrant and primitive.

Suggested teaching methods:

The subjects dealt with in this module can be used to set up various kinds of reasoning (reductio ad absurdum, contrapositive, induction, counter example ...). Examples of limited expansions can be used (eg calculated with the assistance of software).

Keywords: Increments, Heaviside unit step, Slope.

Networks and Telecommunications DUT**M4**
Elements of applied maths

Teaching unit: UE1, Science and foundation studies

Subject: Maths

No of hours: 30 hours Teaching=10hrs/directed work=15hrs/hands-on=5hrs

Semester: S1/S2

Targets:

- To understand the first principles of matrix calculus,
- To use Laplace transforms.

Minimum skills acquired:

The ability to:

- use a formula to calculate direct and inverse Laplace transforms,
- perform operations on matrices,
- solve a linear system (5th order or lower).

Previous study required: Module M3 (Integral calculus)

Content:

- Laplace transforms of causal functions
- Table and theorems. Inverse transforms
- Applications
- Operations on matrices
- Basic properties of determinants
- Calculation of determinants (4th order or lower)
- Solving linear systems

Possible extensions:

- Transfer functions
- Impulse response
- Convolution
- Error-correcting codes
- Quadropole matrices
- Convolution matrices

Keywords: Formal calculus, Tableaux, Circuits.

Networks and Telecommunications DUT**CC1****Communication through self-expression**

Teaching unit: E1, Science and foundation studies

Subject: Culture – Communication

No of hours: 30 hours directed work=10hrs/hands-on=20hrs

Semester: S1/S2

Targets:

- to master communication codes,
- to be able to use verbal and non-verbal communication.

Minimum skills acquired:

The ability to produce and understand short messages, both spoken and written, whilst adhering to the basic rules of communication.

Previous study required: Baccalaureat or equivalent.

Content:

- Concepts of communication analysis
- Written: expanding the vocabulary, note taking, writing methods and techniques
- Oral: speaking with confidence, listening to and respecting others when they speak
- Concepts of communicating through images

Suggested teaching methods:

- work done partly alone and partly in a team
- use of office automation tools
- writing letters, reports, emails
- oral presentations
- possible formats: role plays – interviews – video diaries – writing workshops – press reviews ...

Possible extension:

- Using video conferencing systems

Keywords: language, listening, expressing, writing.

Networks and Telecommunications DUT**A1****English for everyday communication and introduction to technical vocabulary**

Teaching unit: UE1, Science and foundation studies

Subject: English

No of hours: 45 hours directed work =15hrs/hands-on=30hrs

Semester: S1/S2

Targets:

- For students to be confident in communication situations.

Minimum skills acquired:

The ability to:

- introduce oneself and introduce another person (good command),
- describe, ask questions and give simple responses (good command),
- command of English in everyday communication situations (communication/good command),
- present communication tools in the telecommunications and networks field and their uses (information/good command).

Previous study required: Baccalaureat or equivalent.

Content:

- Reinforcing skills learnt in foundation studies
- Basic grammar, vocabulary and syntax concepts, used whiles working towards the targets
- Introducing specialist vocabulary

Suggested teaching methods:

- Working in twos and small groups in communication situations

Keywords: Reaching required level, oral, expression, communication.

Networks and Telecommunications DUT

I1

Using computer operating systems

Teaching unit: UE2, IT and Electronics

Subject: IT

No of hours: 30 hours Teaching=6hrs/directed work=4hrs/hands-on=20hrs

Semester: S1/S2

Targets:

- To understand the role of operating systems and to be familiar with computer file systems.

Minimum skills acquired:

Using different operating systems, the student should be able to:

- start a session,
- organise and handle files (in text mode and graphics mode) taking access rights into account,
- bootstrap and control the execution of an application,
- initialise environment variables and automate the concatenation of basic commands in a script.

Previous study required: Baccalaureat or equivalent.

Content:

- System commands
- Directories and files
- Concepts of users and rights
- Environment variables
- Basic scripts
- Using basic data processing tools

Possible extensions:

- IT Module: Operating Systems and System Programming (module IC-1)
- Network module: System administration

Keywords: Operating system, System commands, Scripts

Networks and Telecommunications DUT**I2****Representing information and data processing machine architecture**

Teaching unit: UE2, IT and Electronics

Subject: IT

No of hours: 60 hours Teaching=15hrs/directed work=25hrs/hands-on=20hrs

Semester: S1/S2

Targets:

- To be able to understand and use notation and encoding systems, the basic components of digital machines and how they are structured.

Minimum skills acquired:

The ability to:

- identify the basic components of a digital processing system,
- express a piece of information (digital or alphanumerical) in different encoding systems,
- define the routing of data and hardware addressing,
- describe polling and interrupt input-output mechanisms.

Previous study required: Baccalaureat or equivalent.

Content:

- Notation, encoding
- Boolean algebra
- Digital electronic circuits: combinatory and sequential logic (synchronous and asynchronous), programmable circuits
- Bus, memory, input / output
- Interrupts
- Microprocessors, microcontrollers

Possible extensions:

- Active network architecture
- Telecommunications: FPGA, DSP, etc.
- Hardware description language

Keywords: Representing information, Addressing mode, Programmable circuits.

Networks and Telecommunications DUT**E1****Linear circuit analysis tools**

Teaching unit: UE2, I.T. and Electronics

Subject: Electronics

No of hours: 60 hours Teaching=12hrs/directed work=24hrs/hands-on=24hrs

Semester: S1/S2

Targets and Minimum skills acquired:

The ability to:

- use linear circuit analysis methods and tools,
- characterise components (order of magnitude),
- grasp measurement techniques and use the equipment.

Previous study required: Baccalaureat or equivalent.

Content:

- Linear circuits:
 - Essential laws and theorems for circuit calculus.
 - Study of transient and harmonic balance states of passive circuits.
- Measurements :
 - Using and operating measuring equipment.
 - Time and spectrum representation of signals.
- Frequency response (Bode).
- 1st and 2nd order system responses

Possible extensions:

- Module T1: Signals and Systems

Suggested teaching methods:

- Oscilloscope with FFT function

Keywords: Ohm, Thévenin, Norton

Networks and Telecommunications DUT**E2****Amplification Function**

Teaching unit: UE2, IT and Electronics

Subject: Electronics

No of hours: 30 hours Teaching=6hrs/directed work=12hrs/hands-on=12hrs

Semester: S1/S2

Targets – Minimum skills acquired:

The ability to:

- analyse basic layouts,
- select an amplifier taking into account specific needs and its technological limitations.

Previous study required: Module E1

Content:

- Amplification functions for voltage, current and power
- Operational Amplifiers (OAs) used in linear mode
- Imperfections of an amplifier
- Gain-bandwidth product, « Slew-rate »
- Active filtering: structure, response.
- Gabarit, Butterworth, Tchebychev

Possible extensions:

- Supplementary electronics modules

Suggested teaching methods:

- Using real components and simulations

Keywords: Equivalence model, Operational amplifier, active filter

Networks and Telecommunications DUT**T1**
Signals and Systems

Teaching unit: UE3, Telecommunications and Networks

Subject: Telecommunications

No of hours: 60 hours Teaching=10hrs/directed work=20hrs/hands-on=30hrs

Semester: S1/S2

Targets:

The aim of this module is to introduce telecommunications systems and Voice-Data-Image type signals.

Minimum skills acquired:

The ability to:

- define signal properties and measure signals in terms of time and frequency,
- use the relevant measuring instruments.

Previous study required: Baccalaureat or equivalent.

Content:

- Overall structure of a transmission system
- Description, properties and units of measurement of signals
- Time and frequency representation of signals, spectrum analysis
- Analogue modulations and demodulations
- Characterising systems: transfer function, link budget, examples of propagation media: copper, fibres, wireless.

Possible extensions:

Suggested teaching methods: Teaching to be delivered after module E1. Use of FFT oscilloscopes, spectrum analysers, instrumentation. In view of the sequence of the modules, the mathematical tools needed to understand this module can be introduced.

Keywords: signal - frequencies – measurements

Networks and Telecommunications DUT**R1****General network concepts**

Teaching unit: UE3, Telecommunications and Networks

Subject: Networks

No of hours: 30 hours Teaching=12hrs/directed work=12hrs/hands-on=6hrs

Semester: S1/S2

Targets – Minimum skills acquired:

The aim of this module is to introduce the basic principles of networks. Students should be able to understand and assimilate the fundamental concepts relating to the architecture of communication networks and routing of information, as well as the regulatory framework governing this area.

Previous study required: Baccalaureat or equivalent.

Content:

- Needs analysis
- Different types of network (voice/data, LANs/WANs,...)
- Standards: Bodies, RFCs, whitepapers...
- service quality: Throughputs, lead times, error rates ...
- Network architectures
- Physical and logical topology
- Models
- Services, protocols, encapsulation, addressing.
- Examples: OSI, TCP/IP...
- Switching (circuit, message, packet) and routing.
- Connected and non-connected modes.
- Physical layer
- Elements of transmission
- Error detection and correction
- Flow control
- Security: Integrity, authentication, confidentiality.

Keywords: networks, Regulatory framework, architectures, security.

Networks and Telecommunications DUT

R3

Administering network operating systems

Teaching unit: UE3, Telecommunications and Networks

Subject: Networks

No of hours: 30 hours Teaching=2hrs/directed work=4hrs/hands-on=24hrs

Semester: S1/S2

Targets – Minimum skills acquired:

The ability to:

- install, configure and supervise a system,
- create and manage users and files,
- grasp the basic principles of administration of a network operating and user management system.

Previous study required: Module IT I1

Content:

- Installation and configuration of servers and workstations
- Workstation rollout
- User management
- File management (sharing, access rights and backup...)
- Audit Strategies

Possible extensions:

- TR-c9 Network Administration and Supervision

Suggested teaching methods: teaching based mainly on hands-on work.

Keywords: Installation, administration,

5.2 2nd Semester

Networks and Telecommunications DUT

M3

Integral calculus and differential equations

Teaching unit: UE1, Science and foundation studies

Subject: Maths

No of hours: 30 hours Teaching=10hrs/directed work=15hrs/hands-on=5hrs

Semester: S1/S2

Targets:

- To enable students to apply integral and differential calculus tools to other disciplines.

Minimum skills acquired:

The ability to:

- master the necessary integration techniques,
- solve the differential equations in the programme.

Previous study required: Modules M1 and M2

Content:

- Integration techniques
- Integrating ordinary trigonometric functions
- Integrating rational fraction functions
- 1st and 2nd order linear differential equations with constant coefficients
- Equivalent functions in the region of infinity
- Improper integrals of the type:

$$\int_a^{+\infty} f(t) dt \quad \int_{-\infty}^{+\infty} f(t) dt$$

(definitions, convergence, theorems on positive functions, absolute convergence of complex value functions)

Possible extensions:

- Convolution
- Correlation
- Solving a differential equation numerically using Euler's method
- Solving differential equations in applied physics
- 1st order linear differential equations with non-constant coefficients

Suggested teaching methods:

The formal approach will lead into applications in various fields (electrical circuits, demographic evolution models, physics, etc). Hands-on software sessions could be used for numerical integration methods (rectangle, trapezium).

Keywords: Variable, Summation, Primitive

Networks and Telecommunications DUT

M5

Mathematical tools for Fourier Analysis

Teaching unit: UE1, Science and foundation studies

Subject: Maths

No of hours: 30 hours Teaching=10hrs/directed work=15hrs/hands-on=5hrs

Semester: S1/S2

Targets:

- To be able to understand the time/frequency duality.

Minimum skills acquired:

The ability to:

- write out any simple periodic signal as a Fourier series,
- write out and easily calculate Fourier transforms of simple functions and recognise the characteristics of the transforms,
- to use frequency representation.

Previous study required: Modules M1, M2 & M3.

Content:

- Integral of e^{mx} (complex m)
- Dirac impulse
- Convolution
- Fourier series of a periodic function
(Real and harmonic series, complex series, spectrum, Parseval's theorem)
- Fourier transforms of ordinary functions
(Bounded media, summable functions)

Possible extensions:

- Spectrum analysis
- Impulse response, frequency response
- Sinusoidal transfer functions
- Amplitude modulation
- Sampling

Keywords: Frequency, Sinusoidal, Shannon.

Networks and Telecommunications DUT**P1****Fundamentals of Physics**

Teaching unit: UE1, Science and foundation studies

Subject: Physics

No of hours: 30 hours Teaching=11hrs/directed work=16hrs/hands-on=3hrs

Semester: S1/S2

Targets:

- familiarity with the concepts of electrical fields and magnetic fields,
- familiarity with the characteristics of basic passive components.

Minimum skills acquired:

The ability to:

- explain the electrical behaviour of basic passive components,
- grasp the basic concepts of electromagnetism.

Previous study required: S or STI electronics – electrical engineering baccalaureat programme.

Content:

- Electrostatics: force, electrical field and potential, capacitors.
- Electrokinetics: intensity, resistance.
- Electromagnetism: magnetic field, inductions phenomena, inductance.
- Introduction to propagation phenomena (stationary , quasi-stationary and other states...).

Suggested teaching methods:

Use of multimedia resources to illustrate physical phenomena

Keywords: Coulomb, Gauss, Ampere, Lenz, Resistance, Capacitor, Inductance.

Networks and Telecommunications DUT

CC2

Giving information & keeping records

Teaching unit: UE1, Science and foundation studies

Subject: Culture – Communication

No of hours: 30 hours directed work=10hrs/hands-on=20hrs

Semester: S1/S2

Targets:

- ability to keep records, gather and analyse information,
- reason out a personal reflection,
- produce documents and oral presentations.

Minimum skills acquired:

- understanding and reformulating another person's thinking,
- to read, interpret and put to use a general or technical dossier,
- summarising.

Previous study required: Module CC1.

Content:

- researching information on a general or technical subject
- relevant use of the internet – selecting a variety of sources
- structuring our thoughts and the way they are expressed
- a look at the current cultural climate

Suggested teaching methods:

- work done partly alone, partly as a team
- writing resumés of documents
- analysing textual and graphic material
- documentary research
- learning to use audio-visual resources and ICT
- giving talks
- carrying out individual and team projects (presentations, audio-visual productions, cultural visits, etc.)
- reading and analysing press

Keywords: documentation, structuring, presentation, general culture.

Networks and Telecommunications DUT**A2****Further technical English and new technologies**

Teaching unit: UE1, Science and foundation studies

Subject: English

No of hours: 45 hours directed work =15hrs/hands-on=30hrs

Semester: S1/S2

Targets:

- Improving students' technical English,
- Familiarity with new technologies.

Minimum skills acquired:

The ability to:

- research, understand, summarise, express in common language and present technical data both in writing and orally,
- analyse, summarise, reason and debate,
- gain a perspective of new technologies in the world and develop a critical approach.

Previous study required: Module A1.

Content:

- Developing the essential vocabulary for the specialisation
- Consolidating methodologies for oral communication techniques
- Introduction to new technologies
- Overall study progression

Suggested teaching methods:

- Oral presentations, studying specific written and audio-visual material
- Work in small groups and pairs
- Communication situations. Multimedia documents
- Using the language laboratory

Keywords: Technique, Understanding, Summarising, Multimedia, Group discussion, Debates.

Networks and Telecommunications DUT

I3

Algorithmics and programming

Teaching unit: UE2, IT and Electronics

Subject: IT

No of hours: 60 hours Teaching=10hrs/directed work=20hrs/hands-on=30hrs

Semester: S1/S2

Targets:

- To be able to propose a software solution which compiles with a set of simple specifications.

Minimum skills acquired:

The ability to:

- create an algorithm from a set of simple specifications,
- transcribe an algorithm into a structured language,
- compile, correct and test a programme.

Previous study required: Baccalaureat.

Content:

- Algorithms
- Structured programming,
- Variables, data structures, addressing
- Control structures, sub-programmes

Possible extensions:

- IT Module: Object-oriented programming (module no. I5)
- IT Module: Advanced algorithmics (module no. I-C2)
- Software engineering

Suggested teaching methods:

- Distance learning

Keywords: Algorithms, Programming language

Networks and Telecommunications DUT

I4
Databases

Teaching unit: UE2, IT and Electronics

Subject: IT

No of hours: 30 hours Teaching=6hrs/directed work=12hrs/hands-on=12hrs

Semester: S1/S2

Targets:

- To create and use a simple relational database using a database management system.

Minimum skills acquired:

The ability to:

- design a model for and create a simple relational database,
- create a database using a Database Management System,
- query and manipulate a database using a query language.

Previous study required: Baccalaureat or equivalent.

Content:

- Creating a model for and designing a database (integrity constraints)
- User and client configuration concepts
- Manipulating the elements (tables, etc.) using a Database Management System
- Query language (data querying), relational algebra concepts

Possible extensions:

- Installing and administering database management systems
- Distributed databases
- Object modelling
- IT Modules:
 - Client-server and Web applications (module I-C3)
 - Advanced databases (module I-C5)

Keywords: DBMSs, Relational, Query languages

Networks and Telecommunications DUT**E3****Functions for transmissions**

Teaching unit: UE2, IT and Electronics

Subject: Electronics

No of hours: 30 hours Teaching=6hrs/directed work=12hrs/hands-on=12hrs

Semester: S1/S2

Targets – Minimum skills acquired:

The ability to:

- analyse and use the components and functions for telecommunications,
- analyse and use conversion functions.

Previous study required: Module E2, Module I2

Content:

- Diodes and their applications
- Comparison function
- Multiplying function
- Signal notation and restitution
- Analogue switch
- Time based multiplexing & demultiplexing
- Analogue-digital conversion (ADC)
- Digital-Analogue Conversion (DAC)

Possible extensions:

- Module T2 Digital Transmissions

Suggested teaching methods:

- Operational amplifiers in non-linear mode

Keywords: ADC, DAC, Modulation/demodulation

Networks and Telecommunications DUT**T2****Digital Transmissions**

Teaching unit: UE3, Telecommunications and Networks

Subject: Telecommunications

No of hours: 60 hours Teaching=10hrs/directed work=20hrs/hands-on=30hrs

Semester: S1/S2

Targets:

- Familiarity with digital transmission techniques.

Minimum skills acquired:

The ability to:

- describe the coding for a transmission channel (junctions, modem, baseband encoder),
- qualify and test digital transmission systems.

Previous study required: module T1

Content:

- Overview of a digital transmission channel
- Notation (sampling, quantisation, encoding)
- Describing the properties of a transmission (synchronous mode, asynchronous mode, rate, valency, error rate)
- Information-signal transcoding (study of main codes)
- Influence of the domain on transmission (in baseband and in converted band)

Possible extensions:**Suggested teaching methods:**

The mathematical concepts required for understanding this module should be introduced. The PCM frame is a good way of illustrating the concepts dealt with in this module.

Keywords: Emitter, Receiver, Baseband – Modem

Networks and Telecommunications DUT**T3**
Telephony

Teaching unit: UE3, Telecommunications and Networks

Subject: Telecommunications

No of hours: 30 hours Teaching=6hrs/directed work=9hrs/hands-on=15hrs

Semester: S1/S2

Targets:

- understand the principles of telephony,
- set up a private telephone network.

Minimum skills acquired:

The ability to:

- calculate the measurements, install, configure and maintain a private telephone network,
- cabling, configuration and activation of a PABX.

Previous study required: Baccaalaureat or equivalent.

Content:

- General principles of telephony
- Public and private network architectures
- Private networks (switching, signalling, services, cabling standards)
- Evolution of telephony

Possible extensions:

- TR-c7 Mobile telephony

Suggested teaching methods:

- Participation of professionals (seminars, demonstrations, hands-on work...)

Keywords: Telephony – PABX

Networks and Telecommunications DUT**R2****Local area networks**

Teaching unit: UE3, Telecommunications and Networks

Subject: Networks

No of hours: 30 hours Teaching=8hrs/directed work=10hrs/hands-on=12hrs

Semester: S1/S2

Targets – Minimum skills acquired:

The ability to:

- install and validate wiring,
- roll out and troubleshoot a local area network, using both wired and wireless technologies,
- master the basic concepts of local area networks: sharing media, switching, protocols.

Previous study required: Module R1

Content:

- IEEE standard for LANs.
- Equipment and wiring: setting up and validating.
- Probabilistic and deterministic access methods.
- Data link layer protocols for wired and wireless networks.
- Ethernet Technology, ...
- Level 2 interconnects, VLANs, ...

Possible extensions:

- TR-c9 Network administration and supervision

Suggested teaching methods: Analysing frames

Keywords: Local area networks, Ethernet, Wiring.

Networks and Telecommunications DUT**R4**
IP Technology

Teaching unit: UE3, Telecommunications and Networks

Subject: Networks

No of hours: 60 hours Teaching=10hrs/directed work=20hrs/hands-on=30hrs

Semester: S1/S2

Targets – Minimum skills acquired:

The ability to:

- set up a LAN architecture and remote access points,
- propose, implement and test an addressing plan,
- configure the associated equipment,

Students should be familiar with the principles of interconnection of IP networks and have detailed knowledge of the IP protocol and the associated mechanisms.

Previous study required: Module R2

Content:

- Addressing, IP protocol
- Interconnects and routing
 - Related protocols (ARP, ICMP, ...)
 - Putting these into practice on LANs and Point-to-Point links.
 - Presentation of the services offered by the TCP/IP protocol stack.

Possible extensions:

Suggested teaching methods: IPv4, IPv6. Can be restricted to static routing. Analysis of protocols.

Keywords: IP, Addressing plan, interconnects

5.3 3rd Semester

Networks and Telecommunications DUT**M6****Mathematics for discrete signals**

Teaching unit: UE1, Science and foundation studies

Subject: Maths

No of hours: 30 hours Teaching=10hrs/directed work=15hrs/hands-on=5hrs

Semester : S3

Targets:

- Familiarity with concepts of convergence and summability
- To be able to use the Z transform.

Minimum skills acquired:

The ability to:

- determine the convergence domain of a whole series or a Z transform,
- write out the expansion of programme functions as whole series,
- use a formula to calculate direct and inverse Z transforms,
- solve a difference equation.

Previous study required: Module M3.

Content:

- Definitions in numerical sequences
- Geometrical sequences
- Numerical series
- Whole series (definitions, disc of convergence, operations derivation, integration, ordinary whole series expansions)
- Z Transforms (definitions of bilateral transforms, properties of the unilateral transform)
- Discrete convolution
- Application to difference equations

Possible extensions:

- Applying whole series to solving differential equations
- Limited expansions
- Original calculations using the residual method
- Properties of the bilateral Z-transform

Keywords: Filtering, Convergence, Summation.

Networks and Telecommunications DUT**P2**
Applied Physics

Teaching unit: UE1, Science and foundation studies

Subject: Physics

No of hours: 30 hours Teaching=10hrs/directed work=14hrs/hands-on=6hrs

Semester: S3

Targets:

- Knowledge of the propagation properties of an electromagnetic wave.

Minimum skills acquired:

The ability to:

- understand the basic phenomena occurring during transmissions,
- analyse the effects resulting from these.

Previous study required: Module P1.

Content:

- Definition of an electromagnetic wave.
- Emission and reception of an electromagnetic wave.
- Guided-space and free-space propagation, attenuation, dispersion.
- Transmission lines
- Geometric optics, reflexion, refraction.
- Wave optics, interference.

Possible extensions:

- Electromagnetic compatibility

Keywords: Aerials, Cables, Wave guides, Optical fibres.

Networks and Telecommunications DUT

CC3

Integrating and communicating in a work environment

Teaching unit: UE1, Science and foundation studies

Subject: Culture – Communication

No of hours: 45 hours directed work=15hrs/hands-on=30hrs

Semester : S3

Targets:

- preparing for employment,
- communicating in a work environment,
- adapting to the socioprofessional environment.

Minimum skills acquired:

- to identify the working environment,
- to identify one's relationship network,
- find a workplace training course,
- successful job-hunting,
- to be comfortable expressing oneself both orally and in writing,
- adapting to one's interlocutor,
- manage a document database and produce a summary of it,
- integration and teamwork.

Previous study required: Module CC2.

Content:

- job seeking techniques: traditional tools (motivation letters, CVs), phoning, tests
- training for job interviews
- methods for writing professional documents (summary notes)
- effective communication: evaluation by self and others of the effectiveness of one's communication skills
- writing professional documents (reports, dossiers, specifications, summaries...)
- identifying group phenomena
- mastering groupwork techniques
- speaking at meetings

Suggested teaching methods :

- personal resumé
- writing motivational letters and CVs
- approaches for finding training courses and employment
- simulated job interviews
- getting to know companies (organising forums, trade fairs, conferences, visits to businesses...)
- role plays

Keywords: workplace training, employment, organising, interacting, working together.

Networks and Telecommunications DUT**CE1****Business awareness**

Teaching unit: UE1, Science and foundation studies

Subject: Business awareness

No of hours: 30 hours Teaching =10hrs/directed work=20hrs

Semester : S3

Targets:

- gain an awareness of the enterprise as an organisation from a society, economy and people point of view.

Minimum skills acquired:

The ability to:

- identify the major functions of an enterprise and one's role within the structure of the enterprise,
- understand the enterprise within its environment,
- identify the elements which go towards the cost of a product.

Previous study required: Baccaalaureat or equivalent.

Content:

- the structure of the company system: features, organisation and internal roles, company-employee relationship, management, employment law
- the enterprise as a profit centre: a company's financial activities, accounting documents, cost hierarchies, marketing
- the enterprise and its environment: company culture: the company and its image

Suggested teaching methods:

- the involvement of business people coming from companies is highly desirable at this point.

Possible extensions:

- Workplace training, tutored project

Keywords: Employment contract, human resources, company culture, profitability.

Networks and Telecommunications DUT**A3****The world of work**

Teaching unit: UE1, Science and foundation studies

Subject: English

No of hours: 30 hours directed work =10hrs/hands-on=20hrs

Semester : S3

Targets:

- Knowledge of the world of business and job hunting.

Minimum skills acquired:

The ability to:

- Understand a job offer,
- Produce a CV,
- Produce a motivational letter,
- Go through a job interview,
- Speak up, argue a point, negotiate, convince,
- Give a report.

Previous study required: Modules A1 and A2.

Content:

- Study of the different stages in job hunting and of business culture (in France and abroad)

Suggested teaching methods:

- Working in small groups
- Research, writing, presentations, simulated job interviews, meetings
- potential for using video-conferencing

Keywords: Working life, Employment

Networks and Telecommunications DUT**I5****Object-oriented programming**

Teaching unit: UE2, IT and Electronics

Subject: IT

No of hours: 30 hours Teaching=6hrs/directed work=10hrs/hands-on=14hrs

Semester : S3

Targets:

- Propose an object-oriented software solution which complies with a set of specifications.

Minimum skills acquired:

The ability to:

- design an object and relationship based application,
- transcribe the application into an object-oriented language.

Previous study required: Algorithmics and programming IT module (module I3)

Content:

- Principles of object-oriented programming
- Error management devices

Possible extensions:

- Software engineering
- Component programming
- IT modules:
 - event-driven and network programming (module I6)
 - Client-server and Web applications (module I-C3)

Keywords: object, inheritance, exception

Networks and Telecommunications DUT

I6

Event-driven and network programming

Teaching unit: UE2, IT and Electronics

Subject: IT

No of hours: 30 hours Teaching=6hrs/directed work=6hrs/hands-on=18hrs

Semester : S3

Targets:

- Developing client-server applications and graphics-based user interfaces.

Minimum skills acquired:

The ability to:

- use event-driven mechanisms,
- produce graphics-based user interfaces,
- implement client-server applications.

Previous study required: Object-oriented programming IT module (module I5); IP technology networks module

Content:

- Client-server architecture
- Event-driven programming
- Graphics-based user interfaces

Possible extensions:

- Software engineering
- Programming by component
- Client-server and web applications IT module (module I-C3)

Keywords: client-server, graphics-based user interface

Networks and Telecommunications DUT**E4****Looped systems applied to telecommunications**

Teaching unit: UE2, IT and Electronics

Subject: Electronics

No of hours: 60 hours Teaching=12hrs/directed work=24hrs/hands-on=24hrs

Semester : S3

Targets – Minimum skills acquired:

The ability to:

- recognise basic structures in looped systems as applied to telecommunications,
- put these into practice for frequency synchronisation, demodulation and synthesis.

Previous study required: Module E2

Content:

- Model of a loop
- Stability, precision
- Signal generation and sinusoidal oscillators
- Voltage-frequency conversion
- Phase-locked loops (PLL)

Possible extensions:

- Digital PLLs

Suggested teaching methods:

- Carrier regeneration
- Frequency synthesisers
- Wien bridge, Colpitts & quartz oscillators

Keywords: PLLs, VCO, Modulation/Demodulation

Networks and Telecommunications DUT**TR1****Digital modulations and compression concepts**

Teaching unit: UE3, Telecommunications and Networks

Subject: Telecoms & Networks

No of hours: 30 hours Teaching=6hrs/directed work=9hrs/hands-on=15hrs

Semester : S3

Targets:

To present and explain techniques for matching the signal to the transmission channel.

Minimum skills acquired:

The ability to explain the role of the various elements in the transmission channel.

Previous study required: Module T2

Content:

- Source coding, channel coding
- Digital modulations on carrier frequencies (PSK, FSK, QAM...)
- Introduction to multi-carrier modulations (OFDM, DMT...)
- Introduction to spread spectrum (CDMA...)
- Digital reception
- Compression techniques (with and without loss, impact on errors ...)

Possible extensions:

- TR-c1 Digital signal processing

Suggested teaching methods:

The various functions can be illustrated by using the various compression (audio and video) and modulation standards and conventions

Keywords: Modulation – Compression – Error-correcting codes.

Networks and Telecommunications DUT**TR2**
Internet Technologies

Teaching unit: UE3, Telecommunications and Networks

Subject: Telecoms & Networks

No of hours: 60 hours Teaching=10hrs/directed work=20hrs/hands-on=30hrs

Semester : S3

Targets – Minimum skills acquired:

The ability to:

- install and configure the standard services provided over the Internet network,
- set up a dynamic routing solution.

Students should deepen their knowledge of the functions, protocols and services connected with Internet technology, in particular of aspects relating to routing protocols and services offered. Students will deal with security aspects of networks.

Previous study required: Module R4

Content:

- Concepts and modelling
- Approaches to the Internet: TCP, UDP....
- Dynamic routing: OSPF, RIP, BGP, EGP...
- Network oriented services: DNS, DHCP...
- User oriented services: VoIP, Web, email, directories, file interchanges, multimedia...
- Network security: filtering and access control mechanisms (Proxy-Firewall, NAT, ACL ...), elements of secure services
- Elements of network supervision

Possible extensions:

- TR-c8 Advanced network security
- TR-c12 Telephony over IP

Suggested teaching methods: IPv4, IPv6.

Keywords: Routing, Internet, services, security.

Networks and Telecommunications DUT**TR3****Wide area networks and carriers' networks**

Teaching unit: UE3, Telecommunications and Networks

Subject: Telecoms & Networks

No of hours: 90 hours Teaching=18hrs/directed work=27hrs/hands-on=45hrs

Semester: S3

Targets – Minimum skills acquired:

- knowledge of the various types of physical media and their specific features,
- an understanding of the influence of choice of media on the network protocols used,
- ability to set up equipment,
- a good grasp of the technologies and protocols associated with wide area networks and carriers' networks.

Students should gain some understanding of the technologies and protocols which allow mobile access to wide area networks (both wired and wireless).

Previous study required: Modules R1, T1 , T2

Content:

- Media Architectures and protocols in wide area networks
- Access technologies (local loop...)
- Switching technologies (circuits, frames, ATM cell, packets, ...)
- Transmission networks (SDH, PDH, WDM, ...)
- Signalling in WANs
- Wireless network architecture
- Mobility, Mobile networks

Possible extensions:

- TR-c4 Broadcast networks
- TR-c5 Transmission networks
- TR-c10 Roaming
- TR-c11 Wireless local area networks

Suggested teaching methods:

- Examples of technologies : xDSL, BLR, RNIS, CPL, X25, Frame Relay, ATM, MPLS...
- Configuring and operating networks
- Analysing protocols

Keywords: Multiplexing, mobile telephony, mobile networks, mobility, cellular networks, security.

5.4 4th Semester (list of supplementary modules)

Type of option <i>PE, LP, IP</i>	Category <i>OS, AT or RCP</i>	Module	Target skills
<i>PE</i>	<i>OS</i>	OS-M-C1 Linear Algebra	Ability to express and use diagonalisation (differential systems, etc.)
<i>PE</i>	<i>OS</i>	OS-M-C2 Probability	Putting methods and tools into practice (trees, diagrams and tableaux), ability to perform calculations within the framework of the laws of probability.
<i>PE</i>	<i>OS</i>	OS-M-C3 Statistics and probability	Represent a series in a relevant way, calculate parameters, quantitative validation of smoothing.
<i>PE</i>	<i>OS</i>	OS-M-C4 Mathematics for engineers	Manipulate the functions of several variables and their operators, express and calculate a double integral.
<i>PE</i>	<i>OS</i>	OS-M-C5 : Mathematics for networks and IT	Write out long-hand the matrix associated with a graph, recognise a critical path, give the data of a graph.
<i>LP, IP</i>	<i>AT</i>	P-C1 Optics for telecommunications	Understand the principles of the optical components and functions of telecommunications systems.
<i>PE</i>	<i>OS</i>	OS-P-C2 Electromagnetism	Use mathematical and physical tools to solve propagation equations.
<i>LP, IP</i>	<i>RCP</i>	A-C1 Projects abroad	Preparing to be independent in the host country, giving an account of the work carried out and the nature of the experience.
<i>LP, IP</i>	<i>RCP</i>	A-C2 Technical English and Personal Project	Summarise technical documents in English, independent research on a technical subject, ability to give a written or oral report on technical subjects.
<i>LP, IP</i>	<i>AT</i>	I-C1 Operating systems and System Programming	Describe the architecture of operating systems and how they work, write a multi-process application and automate system administration.
<i>PE</i>	<i>OS</i>	OS-I-C2 Algorithmics	Manipulate complex data structures, implement search and sort algorithms.
<i>LP, IP</i>	<i>RCP</i>	I-C3 Client-server and Web Applications	Design dynamic websites, content definition languages, incorporate security issues.
<i>LP, IP</i>	<i>RCP</i>	I-C4 Supervised IT Application	Analyse and carry out a set of specifications and perform a validation.
<i>LP, IP</i>	<i>AT</i>	I-C5 Advanced databases	Set up a DBMS, configure clients, optimise and make secure a database.
<i>LP, IP</i>	<i>AT</i>	E-C1 Broadband amplification and filtering and introduction to HF amplification	Take into account limitations when putting HF techniques into practice.

<i>PE</i>	<i>OS</i>	OS-E-C2 Integrated circuits	Detailed knowledge of electronic structures and functions specific to telecommunications.
<i>LP, IP</i>	<i>AT</i>	E-C3 Electronic structures for optical telecommunications	To set up the components for an optical transmission, carry out and describe the features of an optical transmission.
<i>LP, IP</i>	<i>AT</i>	E-C4 Dedicated electronics applications for telecommunications and networks	Analyse specifications and carry them out, perform the validation.
<i>PE</i>	<i>OS</i>	OS-E-C5 RF systems	Design simple impedance matching circuits, define the active and passive components.
<i>PE</i>	<i>OS</i>	OS-TR-C1 Digital signal processing	Put into practice mathematical tools used in signal processing.
<i>LP, IP</i>	<i>AT</i>	TR-c2 Fibre optic transmissions	To determine the features for an optical link and ensure its maintenance
<i>LP, IP</i>	<i>RCP</i>	TR-c3 Wireless and satellite transmissions	Identify and define the settings for the various elements in a receiver network, measure the associated settings, locate problems.
<i>LP, IP</i>	<i>RCP</i>	TR-c4 Broadcast networks	To set up the most appropriate type of broadcast network, install and maintain audio and video reception elements.
<i>LP, IP</i>	<i>RCP</i>	TR-c5 Transmission networks	Familiarity with the different technologies used in transmission networks.
<i>PE</i>	<i>OS</i>	OS-TR-C6 Digital transmissions	Familiarity with various advanced digital transmission techniques.
<i>LP, IP</i>	<i>AT</i>	TR-c7 Mobile telephony	Configure and test a public or private mobile telephony network (frequency domains, time domains, coverage, handover).
<i>LP, IP</i>	<i>RCP</i>	TR-c8 Advanced network security	Develop a suitable network security policy.
<i>LP, IP</i>	<i>RCP</i>	TR-c9 Network Administration and Supervision	Implement a supervision policy.
<i>LP, IP</i>	<i>AT</i>	TR-c10 Roaming	Set up, configure and maintain equipment providing roaming services.
<i>LP, IP</i>	<i>AT</i>	TR-c11 Local wireless networks	Use of equipment (including cellular networks), performance measurement and analysis, maintenance.
<i>LP, IP</i>	<i>RCP</i>	TR-c12 Telephony over IP	Set up telephony voice equipment, measure and analyse performance, carry out maintenance.
<i>LP, IP</i>	<i>AT</i>	TR-c13 Technological intelligence	Familiarity with the various emerging technologies in telecommunications and networks.
<i>LP, IP</i>	<i>AT</i>	TR-c14 Authentication and directory services	Install and configure a directory service for a network operating system.
<i>LP, IP</i>	<i>RCP</i>	TR-c15 Law and economics for telecommunications	Familiarity with the principles governing the law and economics in the telecommunications field.