IVQ

2730

Telecommunication Systems

Advanced Technician Diploma 2002 onwards

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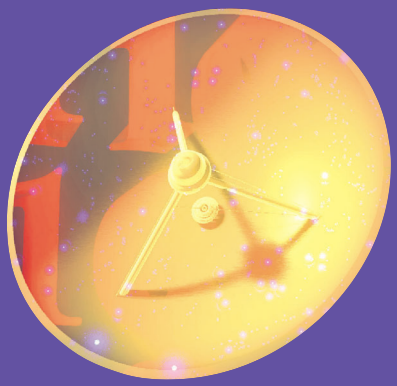

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Telecommunication Systems

2730
Advanced Technician Diploma

2002 onwards

INVESTOR IN PEOPLE

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Contents

2730 Telecommunication Systems

About City & Guilds

We provide assessment and certification services for schools and colleges, business and industry, trade associations and government agencies in more than 100 countries. We have over 120 years of experience in identifying training needs, developing assessment materials, carrying out assessments and training assessment staff. We award certificates to people who have shown they have mastered skills that are based on world-class standards set by industry. City & Guilds International provides a particular service to customers around the world who need high-quality assessments and certification.

About e-skills UK

e-skills UK is the industry representative body responsible for addressing the needs of IT and telecommunications employers in the UK for a world class workforce in the information age.

e-skills UK benchmarked the City & Guilds award in Telecommunication Systems against the occupational standards for the UK telecommunications industry.

In meeting these requirements we at City & Guilds also raised the standard of training design and delivery, an achievement reflected in our accreditation by e-skills UK.

Successful candidates benefit from this accreditation when they apply for jobs in the UK.

Introduction to this programme

We have designed the Technician Awards in Telecommunication Systems for those undergoing training or employed in this area of work. The programme aims to reflect the international nature of the knowledge and skills and activities needed for different countries or cultures.

We do not say the amount of time a candidate would need to carry out the programme, but we do provide advice on guided learning hours for each unit at each level. The programme has three levels.

Certificate

The certificate is an entry-level qualification that has been designed for young people who have just left school, or for anyone seeking a career change. Graduates of the programme should be able to obtain employment within the telecommunications industry at the technician level in the fields of manufacture, installation, maintenance or operation. The certificate will also provide useful underpinning knowledge for those already employed in the industry at the technician or craft level.

The certificate has been designed for a minimum of 300 guided learning hours. Candidates will be expected to study for an equivalent period of their own time, in order to achieve success.

Diploma

The diploma (about 600 guided learning hours) provides more practice involving a broader range of skills appropriate to a person who may also supervise, or who wishes to progress into higher education. Graduates of the diploma should have a well-developed knowledge of the technical and design principles of complex telecommunication systems enabling them to fulfil the role of technician/senior technician across a range of specialised disciplines.

Advanced Diploma

The advanced diploma (600 guided learning hours) takes these skills to the level appropriate to a person preparing for, or working in, first-level management. It is also appropriate for someone who wishes to receive specialised training at a high level. Graduates of the advanced diploma should have a sound knowledge of the technical design principles in one or more specialised branches of telecommunications. They will have the potential to fulfil the role of senior/chief technician with a high level of responsibility requiring the use of personal initiative and critical judgement.

We stress that these figures for guided learning hours are only a guideline. We award certificates for gaining and showing skills by whatever mode of study, and not for periods of time spent in study.

We provide certificates for all work-related areas at seven levels within our structure of awards shown in appendix E. This programme covers level 4. The standards and assessments for the certificate (level 2) and the diploma (level 3) are published separately.

Full Technological Diploma

We will award the Full Technological Diploma (FTD) in Telecommunication Systems to someone who is at least 21, who has had at least two years of related work experience, and who has successfully completed the assessments for the diploma and the advanced diploma levels of this award. If candidates enter for this diploma, they must also send us a portfolio of evidence to support their application.

Making entries for assessments

Candidates can only be entered for the assessments in this subject if the approved examination centres agree. Candidates must enter through an examination centre we have approved to carry out the assessments for 2730 Technician Awards in Telecommunication Systems. See the section on approval and appendix D for more details.

There are two ways of entering candidates for assessments.

Internal candidates

Candidates can enter for examinations if they are taking or have already finished a course at a school, college or similar training institution that has directed their preparation whether by going to a training centre, working with another institution, or by open learning methods.

External candidates

These are candidates who have not finished a programme as described above. The examination centres must receive their application for entry well before the date of the examination concerned. This allows them to act on any advice you give about assessment arrangements or any further preparation needed. External candidates must carry out practical assignments and projects if necessary, and they will need extra time and guidance to make sure that they meet all the requirements for this part of the assessment.

In this publication we use the term 'centre' to mean a school, college, place of work or other institution.

Resources

If you want to use this programme as the basis for a course, you must read this syllabus and make sure that you have the staff and equipment to carry out all parts of the programme. (See appendix B.) If there are no facilities for realistic practical work, we strongly recommend that you develop links with local industry to provide opportunities for hands-on experience.

Assessments

There is one level of Advanced Technician Diploma Award in Telecommunication Systems.

Advanced Diplomas

We use a numbering system to allow entries to be made for our awards. The numbers used for this programme are as follows.

Award number	2730-03
	Advanced Technician Diploma in Applied Telecommunication Systems
	Advanced Technician Diploma in Telecommunication Systems Theory

We use award numbers to describe the subject and level of the award.

Component numbers	021 Telecommunication Project
	022 Advanced Telecommunication Systems
	023 Advanced Radio Systems
	024 Advanced Radio Systems Practice
	025 Software Engineering
	026 Software Engineering Practice
	027 Advanced Mathematics 2
	This unit is an option recommended for candidates entering Higher Education.

We use component numbers to show units for which we may award a certificate of unit credit.

We use these numbers throughout this syllabus. You must use these numbers correctly if you send forms to us.

Advanced Technician Diploma in Applied Telecommunication Systems

To carry out what is needed for the Advanced Technician Diploma in Applied Telecommunication Systems, candidates must be successful in all the following assessments.

[2730-03-021]	Telecommunications Project
2730-03-022	Advanced Telecommunication Systems (written paper which lasts three hours)

Candidates must also be successful in one pair of the following assessments:

either

2730-03-023	Advanced Radio Systems (written paper which lasts three hours)
[2730-03-024]	Advanced Radio Systems Practice

or

2730-03-025	Software Engineering (written paper which lasts three hours)
[2730-03-026]	Software Engineering Practice

(Total two written papers)

The practical assignments are carried out during the learning programme and should be finished by the date of the written examination so you can send all the results to us.
(See appendices C and D.)

To receive this award candidates must carry out the following practical assignments:

- 021/1
- and either 024/1
- or 026/1.

(Total two practical assignments)

Advanced Technician Diploma in Telecommunication Systems Theory

To carry out what is needed for the Advanced Technician Diploma in Telecommunication Systems Theory, candidates must be successful in all the following assessments.

[2730-03-021]	Telecommunication Project
2730-03-022	Advanced Telecommunication Systems (written paper which lasts three hours)

Candidates must also be successful in one of the following units:

2730-03-023	Advanced Radio Systems (written paper which lasts three hours)
2730-03-025	Software Engineering (written paper which lasts three hours)

(Total two written papers)

There are no practical assignments for this award.

We provide assessments in two ways.

a ***Fixed date.***

These are assessments that are carried out on dates and times we set. These assessments have no brackets around their numbers.

b ***Free date.***

These are assessments that are carried out at a college or other training establishment on a date or over a period that the college chooses. These assessments have brackets around their numbers.

In this programme the written assessments are fixed date. The practical assignments and the project are free date.

You must carry out assessments according to our International Directory of Examinations and Assessments. If there are any differences between information in this publication and the current directory, the directory has the most up-to-date information.

Results and certification

Everyone who enters for our certificates, diplomas, and advanced diplomas receives a 'Notification of Candidate Results' giving details of how they performed.

If candidates successfully finish any assessment within this programme (for example, any one of the examination papers) they will receive a certificate of unit credit towards the certificate or diploma for which they are aiming. We grade course work assessments as pass or fail. We grade written assessments on the basis of fail, pass, credit or distinction. The certificate of unit credit will not mention assessments that they do not enter, which they failed or from which they were absent.

Each certificate or diploma clearly states what candidates need for full certification at the relevant level, allowing schools, colleges and employers to see whether they have met the full requirements.

If candidates successfully finish all the requirements for a full certificate or a diploma, they will automatically receive the appropriate certificate.

We will send the 'Notification of Candidate Results', certificates of unit credit, certificates, diplomas and advanced diplomas to the examination centre to be awarded to successful candidates. It is your responsibility to give the candidates the certificates. If candidates have a question about the results and certificates, they must contact you. You may then contact us if necessary.

We will also send you a results list showing how all candidates performed.

How to offer this programme

To offer this programme you must get approval from us. There are two categories of approval.

Subject approval

We give approval to offer a teaching course based on this syllabus.

Examination centre approval

We give approval to enter candidates for examinations.

To be approved by us to offer a teaching course you must send us the application form.

To enter candidates for examinations you must be approved by us as an examination centre. You must use the same application form. For this programme it is possible to act as a registered examination centre only, and accept external candidates. Please read the sections on making entries, results and certification, and appendix D before you make this decision. Approved examination centres must provide suitable facilities for taking examinations, secure places to keep the examination papers and materials, and may have an appointed visiting verifier to review practical work.

If you are already a registered examination centre, you only need to fill in the application form to offer teaching courses for this programme.

After we have received and accepted an application, we will send an approval letter confirming this. You can then send entries in at any time using the International Directory of Examinations and Assessments for guidance.

We show the administration procedures associated with this programme in appendix D.

City & Guilds reserves the right to suspend an approved centre, or withdraw its approval from an approved centre or for an approved centre to conduct a particular City & Guilds scheme or particular City & Guilds schemes, for reason of debt, malpractice or for any reason that may be detrimental to the maintenance of authentic, reliable and valid qualifications or that may prejudice the name of City & Guilds.

Other information

Designing courses of study

Candidates for the various Technician Awards in Telecommunication Systems will have come from different backgrounds and will have different employment and training experiences. We recommend the following:

- carry out an assessment of the achievements so you can see what learning they already have and decide the level of entry they will need; and
- consider what learning methods and places will best suit them.

When you assess a candidate's needs, you should design teaching programmes that consider:

- what, if any, previous education qualifications or training the candidate has, especially in the various general vocational education certificates we provide; and
- what, if any, previous practical experience the candidate has which is relevant to the aims of the programme and from which they may have learned the relevant skills and knowledge.

When you choose learning methods and places, you should consider the results of your assessments and whether the following are available.

- Open or distance learning material.
- Workplace learning that can be carried out on site or between you and a local workplace. This will allow the candidates access to specialised equipment and work experience.
- Working with other registered centres to share facilities.
- Opportunities for co-operative learning between candidates for different certificates who need to gain similar skills.

As long as the candidates meet the aims of this learning programme the structures of courses of study are up to you. So, it is possible to include extra topics that meet local needs.

Nevertheless, we strongly recommend to offer and test the following component in the first year of the Advanced Diploma course:

2730-03-022 Advanced Telecommunication Systems

We advise candidates to choose one of the following options for year two, to be tested at the end of that year:

2730-03-023 Advanced Radio Systems

2730-03-025 Software Engineering

The Telecommunications Project is based on knowledge acquired at the Certificate and Diploma levels, as well as in component 022 of the Advanced Diploma. We recommend that you start with preliminary scheduling and planning of the project at an early stage in year one of the Advanced Diploma.

We advise candidates who have chosen Advanced Mathematics 2 to start with this component in year one, and we recommend that the test take place at the end of year one, to give candidates the chance to repeat this component in the second year.

You should avoid teaching theory alone. As far as possible the practical work should be closely related to work in the classroom (integrative approach) so that candidates use their theory in a realistic work environment.

You can use formal lectures in the classroom with appropriate exercises and demonstrations. Candidates should keep records of the practical work they do so they can refer to it at a later date.

We assume that you will include key skills, such as numeracy, communication, working with people, and organisation and planning throughout a teaching programme.

Presentation format of units

Practical competences

Each unit starts with a section on practical competences which shows the practical skills candidates must have.

At times we give more detail about important words in each 'competence statement'.

For example

1.4 Explain the benefits of the standardisation of protocols and of the formation of standards bodies.
Benefits: interoperability, standardisation
Standards bodies: Internet Engineering Task Force (IETF), International Standards Organisation (ISO)

In the above statement the words 'benefits' and 'standards bodies' are given as a range which the candidate should be familiar with. Candidates should cover the complete range. When a range starts with the abbreviation 'eg' the candidates only need to cover some of the ranged areas or you can use suitable alternatives.

Knowledge requirements

Immediately after the section on practical competences the unit tells you what knowledge is needed for that area. The knowledge needed is closely linked to the practical competences, so it is best to teach the two together so that the candidate appreciates the topic more.

Practical assignments

You should make sure all practical assignments are supervised and instructors should make sure that the results reflect the candidate's own work. You must hold all the documents and material in a file (portfolio) for each candidate for eight weeks after the application for a certificate.

Entry levels

We consider the following programmes to be relevant preparation for this programme.

Technician Diploma in Telecommunication Systems (2730)

We also consider the following Pitman Qualification award as relevant alongside this programme.

English for Speakers of Other Languages – higher intermediate level

We also consider the following joint City &Guilds and NEBS Management award as relevant alongside this programme.

International Management Award – Principles of Management

Progression routes and recognition

A number of universities and other higher education institutions may accept success at diploma and certificate (with appropriate experience) level for direct entry onto bachelor degree programmes. They may also accept success at the advanced diploma level for advanced entry into the second year of these programmes. The decision to accept a candidate onto a degree programme, and the level of entry is at the discretion of the individual institution.

Useful publications

We have listed relevant text books covering specific areas of this programme in each section and also can provide a list of suggested text books. We may also have knowledge about other support materials. You should make sure that you have the latest information. We will automatically send updated lists to centres we have approved to offer this programme.

We offer the following publications as additional support materials to help you plan the delivery of International Vocational Qualifications:

Guide to the assessment of practical skills in International Vocational Qualifications

Preparing projects & portfolios for International Vocational Qualifications

Visiting Verifier Guide

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Syllabus

2730 Telecommunication Systems

Component and section numbers

Advanced Technician Diploma

021 Telecommunications Project
Practical Assignment 021/1: Analysis and solution for a corporate scenario

022 Advanced Telecommunication Systems

01 Transmission Control Protocol / Internet Protocol (TCP/IP)
02 International standards, recommendations and regulatory authorities
03 Optical fibre systems
04 Transmission systems
05 Routing and switching
06 Intelligent Networks (INs) and call management
07 Internet Data Centres (IDCs)
08 Network management

023 Advanced Radio Systems

024 Advanced Radio Systems Practice
Practical Assignment 024/1: Examination of 2.5G and 3G telecommunications systems

025 Software Engineering

026 Software Engineering Practice
Practical Assignment 026/1: Software Engineering

027 Advanced Mathematics 2

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021 – Telecommunications Project

Introduction

The intention of this unit is to provide an opportunity for candidates to analyse a corporate requirement for telecommunication and networked information systems and propose a global solution to meet the companies' needs, which requires the application and integration of other modules within the Advanced Diploma programme of study.

The aim of the unit is to enable the candidate to

a) acquire project planning, organisation and communication skills
b) acquire experience in methods and techniques for product and process improvement
c) acquire commercial awareness
d) develop personal qualities such as creative ability, imagination, initiative and maturity.

Notes:

1 It is suggested that about 150 guided learning hours should be given to this project.

Book list

A Guide to the Project Management Body of Knowledge: 2000 Edition.
Project Management: A Managerial Approach (4th edition); J.R. Meredith, J. Samuel, Jr. Mantel.
Project Management – Planning and Control Techniques (3rd edition); Rory Burke, Val Joyce.
Telecommunications Projects Made Easy; James Harry Green.

Practical competences

The candidate must be able to do the following:

Specification and analysis

1.1 Select the scenario to be analysed.

1.2 Identify the main elements of the scenario.

1.3 Define the objectives of the scenario.

1.4 Prepare a specification of the solution.

1.5 Determine the tasks to be performed to enable the attainment of the objectives.

1.6 Organise the tasks chronologically.

Scheduling and planning

1.7 Plan the initial programme for designing the solution.

1.8 Estimate the resource requirements for each of the tasks.

1.9 Estimate the time needed to complete each task.

1.10 Prepare a schedule of work.

Execution and performance

1.11 Obtain the information necessary to design the solution.

1.12 Select equipment or methods of operation to carry out each task.

1.13 Perform experimental/investigatory work necessary for the execution of the tasks.

Evaluation and communication

1.14 Evaluate the validity of the results.

1.15 Assess the success of the work undertaken.

1.16 Make recommendations for further work.

1.17 Prepare a project to specified layout.
Layout: eg title page, summary, contents page, list of figures, tables, symbols as required, introduction, work carried out, evaluation of the results, conclusions as related to the aims of the project, practical recommendations, references and appendices

1.18 Ensure that the body of the report includes the following work.
Work: eg relevant background information, clear and precise documentation of the aims of the project, relevant theory, previous work undertaken by other people within the area of activity, the actual work undertaken

1.19 Prepare materials for an oral presentation.
Materials: eg slides/transparencies, flip charts, audio or video tapes, supporting notes

Practical Assignment – Telecommunications Project

Practical assignment 021/1: Analysis and solution for a corporate scenario

1 COMPETENCE REFERENCES

1.1 – 1.19

2 PREPARATION

2.1 *Location of the test*

The training centre or other venue where supervision and appropriate working conditions will be provided.

2.2. *Requirements*

Paper, pens, pencils and ruler or a computer system running appropriate software (eg word processing, computer aided design software) and a printer connected to the system, with paper loaded and set up ready to print.

Manuals for software.

Copy of section 3 and section 6.

2.3. *Instructor notes*

Candidates are required to select and analyse individually a corporate scenario and propose a telecommunications and networked information system solution to meet the companie's needs. This task should be realistically achieved (see section 6 for suitable suggestions) within 60 hours. The project must be agreed between candidate and instructor and must take into account the amount and level of work required and the resources available. The nature of the work must demonstrate the candidate's ability at advanced diploma level.

The project is generally considered to be a student centred activity. The instructor's main responsibility is to create an effective environment. In particular the instructor should check the project objectives, monitor the candidate's progress, advise on project progression, exercise leadership if needed, assist in development of the candidate's skills and knowledge and counsel as appropriate.

Candidates may carry out research and produce materials during the allocated time but the report must be produced at the centre under supervision.

It is recommended that candidates should be allowed adequate time to produce the final report. Candidates may use word processors to produce their report provided they have sufficient word processing skills to do so efficiently.

On completion of the report, candidates are required to carry out an oral presentation of their work to the instructor and peer group. It is envisaged that such a presentation will take between 15-30 minutes.

3 CANDIDATES' INSTRUCTIONS

3.1 You are requested to select and analyse a realistic corporate scenario and propose a telecommunications and networked information systems solution. At each stage of this project you must refer to your instructor for continuous guidance and direction. You must keep a log book summarising the work undertaken each week. This log book will be useful in producing the final report. You have 150 hours to complete this assignment.

3.2 Select an appropriate project and agree it with your instructor.

3.3 Maintain on a regular basis a logbook or diary detailing work undertaken.

3.4 Identify the main elements of the problem to define the objectives of the project.

3.5 Prepare a detailed specification of the problem and organise the tasks to be undertaken chronologically (network diagram or similar).

3.6 Plan the initial programme for solving the problem and determine the resource requirements in terms of time, equipment and materials.

3.7 Prepare a schedule of the work to be carried out (Gantt chart or similar).

3.8 Undertake research in order to obtain the information necessary to solve the problem.

3.9 Select equipment or methods of operation to progress the project.

3.10 Carry out the work necessary for the completion of the project.

3.11 Evaluate the success of the work undertaken and make recommendations for further work.

3.12 Prepare a project report using an appropriate format and layout (see section 6.2), which should contain all the work produced in 3.2 – 3.11 above.

3.13 Prepare an oral presentation and present it to your instructor/colleagues.
Oral presentation: eg notes, overhead transparencies

3.14 Ensure your name is on the report and hand it in to your instructor.

4 MARKING

4.1	Project completed in approximately 150 hours.	( )
4.2	Realistic engineering project selected and agreed with instructor.	[ ]
4.3	Log book or diary maintained throughout the project.	[ ]
4.4	The main elements of the problem identified and the objectives defined.	[ ]
4.5		
	4.5.1 Detailed specification prepared.	[ ]
	4.5.2 Tasks to be undertaken organised chronologically.	[ ]
	4.5.3 Network diagram or similar produced.	[ ]
4.6		
	4.6.1 Initial programme planned.	[ ]
	4.6.2 Resource requirements determined in terms of time, equipment and materials.	[ ]
4.7	Schedule of work prepared (Gantt chart or similar).	[ ]
4.8	Appropriate research undertaken and relevant information obtained.	[ ]
4.9	Appropriate equipment and methods to progress the work selected.	[ ]
4.10	Necessary work carried out to complete project.	[ ]
4.11		
	4.11.1 Success of the project evaluated and work assessed.	[ ]
	4.11.2 Recommendations for further work made.	( )
4.12	Project report completed.	[ ]
4.13	Oral presentation prepared and presented.	[ ]
4.14	Report handed in.	[ ]

5 ASSIGNMENT COMPLETION

The candidate will have satisfactorily completed this assignment if successful in all the items marked with a [ ].

Candidates who fail to achieve the requisite number of outcomes should be encouraged to carry out further work in order to complete the assignment satisfactorily.

6 ASSIGNMENT DOCUMENTATION

6.1 *Choosing a project*

The theme of the project is to investigate the global issues, which relate to the telecommunications and networked information systems of a particular company and propose a solution to improve these aspects of the companies operations in terms of operational procedures and costs. Factors to be considered could include combinations of

- voice and data networks
- convergence issues
- multimedia applications
- access techniques
- data storage
- information systems
- access and security implications
- optimisation of data flow
- future-proofing
- internet facilities
- eCommerce applications
- customer management and relations
- service level agreement issues
- Web marketing
- systems-management
- financial impact and budgetary controls.

Possible areas for project work:

- Improvement of the efficiency or effectiveness of an existing system or process.
- Introduction and commissioning of new networks or equipment.
- Modification of existing networks or equipment to perform new or enhanced operations.
- Improvement of maintenance procedures for networks or selected equipment.
- Introduction of new procedures for measuring, testing and calibrating systems or network equipment.
- Standardisation of processes to ensure a coherent approach for converged networks.

6.2 *Project report writing*

The general layout of the project report should be as follows:

Title page
Summary
Contents page
List of figures, list of tables, list of symbols, as required
Introduction
Work carried out
Evaluation of the results
Conclusions as related to the aims of the project
Practical recommendations
References and appendices.

The work carried out should include:

Relevant background information
Clear and precise documentation of the aims of the project
Relevant theory
Previous work undertaken by other people within the area of activity
The actual work undertaken.

022 Advanced Telecommunication Systems

01 Transmission Control Protocol / Internet Protocol (TCP/IP)

Introduction

The aim of this section is to enable the candidate to

a) develop an in-depth understanding of the TCP/IP protocol
b) attain a high level of understanding of how TCP/IP applications are implemented.

Notes:

1 It is suggested that about 40 guided learning hours should be given to this section.

Book list

Computer Networks & Internets with Internet Applications; Douglas E. Comer and Ralph E. Droms.
Internetworking with TCP/IP, Vol 1: Principles, Protocols and Architecture; Douglas Comer.

Knowledge requirements

The instructor must ensure the candidate is able to:

1.1 Identify accurately classless and classful IP addresses and Classless Inter-Domain Routing (CIDR) blocks.

1.2 Explain the limitations of IP version 4.

1.3 Describe the process of configuring or configure a small network, which deploys supernetting, subnetting and Variable Length Subnet Masks (VLSM).

1.4 Explain the benefits of the standardisation of protocols and of the formation of standards bodies.
Benefits: interoperability, standardisation
Standards bodies: Internet Engineering Task Force (IETF), International Standards Organisation (ISO)

1.5 Briefly explain Request For Comments (RFC) and how they are utilised to arrive at Standards.

1.6 Examine in detail the header of an IP datagram and state the function of each of the fields.
Fields: VERS, HLEN, TIME TO LIVE, SOURCE IP ADDRESS

1.7 Describe the datagram encapsulation process and provide examples.
Examples: IP datagram within an Ethernet frame, IP over Frame Relay

1.8 Explain the process of fragmentation and why it is required.

1.9 Explain the purpose of the Time To Live (TTL) field in the IP datagram and how it is used in the context of an internetwork.

1.10 Explain classful addressing schemes and discuss disadvantages of class determined, default subnet masking.

1.11 Explain how VLSMs introduce flexibility in subnetting, resulting in efficient use of IP addresses.

1.12 State the two methods of representing a subnet mask notation.

1.13 Explain classless addressing (supernetting) and how it has eased the Running Out of ADdress Space (ROADS) problem on the Internet.

1.14 Discuss the effect of supernetting on routing and explain how the issue has been tackled.
Effect: increased routing information

1.15 Explain route summarisation in the context of CIDR.

1.16 Explain IP multicasting and give examples of reserved multicasting addresses.
Examples: 224.0.0.2 all routers on this subnet, 127.0.0.1 loopback

1.17 Give examples of the application of multicasting.
Examples: Webcasting, Link State Advertisements (LSA) in Open Shortest Path First (OSPF)

1.18 Explain in detail the elements that make up a Domain Name Service (DNS) and how the system functions.
Elements: distributed database, domain name space, resolver, root name servers, authoritative name servers, caching, inverse mappings, pointer queries

1.19 Describe a Dynamic Host Control Protocol (DHCP) client/DHCP server session that is successfully completed.
Session: INITIALIZE, DHCPDISCOVER, SELECT, DHCPOFFER

1.20 Explain Network Address Translation (NAT) technique and how it is applied to serve a network.

1.21 List the different implementations of NAT and how they operate.

1.22 Explain the term Quality of Service (QoS) and identify which applications require QoS and how it is implemented in TCP/IP.

1.23 Explain the security issues that arise with the use of the Internet and how IETF have approached the introduction of security to the Internet.

1.24 Describe briefly what IP security (IPsec) protocols are and how they work.

1.25 Discuss issues that arise when the Internet is used for the transmission of sensitive data and the methods deployed to eliminate or minimise potential problems.
Methods: Virtual Private Networks (VPN), tunnelling

1.26 Explain the limitations of IP version IV (IPv4) and how IP version 6 (IPv6) will solve these problems.

022 Advanced Telecommunications Systems

02 International standards, recommendations and regulatory authorities

Introduction

The aim of this section is to enable the candidate to

a) appreciate the need for standards and the regulatory framework within which the Information Communication Technology (ICT) industries operate
b) identify the major international, regional and national standards-making bodies and their internal structures
c) identify the bodies responsible for enforcing and policing standards on a national basis.

Notes:

1 The subjects in this section would benefit if an integrative approach is used.
2 It is suggested that about 20 guided learning hours should be given to this section.

Book list

International Telecommunications Management; B. Elbert.

Knowledge requirements

The instructor must ensure the candidate is able to:

2.1 Describe the advantages and disadvantages of conforming to standards.

2.2 Distinguish between various types of standards.
Types: active, reactive, voluntary, mandatory, de facto, de jure, recommendations, functional

2.3 Determine the roles and responsibilities of national standards-setting bodies.

2.4 Explain the role of the European Telecommunications Standards Institute (ETSI) in the standards development process.

2.5 Explain the role of the International Standards Organisation (ISO) and its sub committees, in developing international standards for data communication.

2.6 Explain the role of the International Telecommunications Union (ITU) and its subcommittees in developing international telecommunication standards.

2.7 Explain the role of the International Electrotechnical Commission (IEC) in developing international standards.

2.8 Explain the role of the American National Standards Institute (ANSI) in developing standards for telecommunication.

2.9 Explain the role of the Institute of Electrical and Electronics Engineers (IEEE) in developing standards for telecommunication and data networks.

2.10 Investigate the methods used for the joint development of standards between the different standards bodies.

2.11 Investigate the use of international conferences, forums and Requests For Comments (RFC) in developing standards.

2.12 Investigate the impetus to deregulate on a regional and national basis.

2.13 Assess the state of competition in local and backbone networks.

2.14 Assess the progress of local loop unbundling.

022 Advanced Telecommunications Systems

03 Optical fibre systems

Introduction

The aim of this section is to enable the candidate to

a) investigate the operation of typical fibre optic communications links
b) demonstrate a knowledge and understanding of the components used for communication over optical fibres
c) compare and contrast the advantages to be gained by communicating over optical fibre transmission lines as compared to:
   i) copper based links
   ii) radio links (line-of-sight microwave and satellite).

Notes:

1 The subjects in this section would benefit if an integrative approach is used.
2 It is suggested that about 60 guided learning hours should be given to this section.

Book list

Advanced Electronic Communication Systems; Wayne Tomasi.

Knowledge requirements

The instructor must ensure the candidate is able to:

3.1 Explain the basic construction of fibre optic transmission lines.

3.2 Describe the component parts of an optical fibre used in communication systems.

3.3 Identify the materials used in the manufacture of the core and cladding for fibre optic transmission lines.
Materials: plastic cladding with plastic core, plastic cladding with glass core (PCS), glass cladding with glass core (glass = doped silica, plastic core = polystyrene or polymethylmethaccrllate; plastic cladding = silicone or teflon)

3.4 Compare and contrast the characteristics of optical fibre and copper transmission lines.

3.5 Evaluate the terms associated with optical fibres.
Terms: reflection, refraction, refractive index, core, cladding, cone of acceptance, critical angle, total internal reflection, dispersion

3.6 Explain how the refractive index of the glass (silica) used for the core and cladding materials can be changed by doping.

3.7 Explain the relevance of Snell's law to fibre optic communication systems and use it to find the 'critical angle' for total internal reflection.
Snell's law: $n_1 \sin \theta_1 = n_2 \sin \theta_2$

Critical angle: $(\theta_c) = \sin^{-1} (n_2 / n_1)$

3.8 Determine the critical angle of incidence given the refractive indices of the materials involved.

3.9 Explain the relevance of the Numerical Aperture (NA) of an optical fibre to communication systems.

3.10 Compare and contrast the types of optical fibre.
Types: single-mode, multimode, graded-index, stepped-index

3.11 Demonstrate the refractive index profile for each type of optical fibre.

3.12 Describe the structure of optical fibres giving typical dimensions.

3.13 Evaluate the transmission losses in optical fibre systems.
Losses: absorption, scattering, radiation, coupling losses, termination losses (splices and terminations)

3.14 Compare attenuation versus wavelength characteristics for typical optical fibres and hence justify the most commonly used wavelengths for optical fibre systems.

3.15 Determine typical attenuation coefficients for the various types of optical fibre and compare these with typical copper based transmission lines.
Types: single-mode, multimode, graded-index, stepped-index

3.16 Evaluate the reasons for signal distortion in optical fibre communication systems.
Reasons: modal dispersion and material (chromatic) dispersion

3.17 Explain the effect of dispersion on the maximum signalling speed (bit rate).

3.18 Explain what is meant by Inter Symbol Interference (ISI).

3.19 Explain the function of the 'eye diagram'.

3.20 Compare and contrast typical Bit Error Rates (BER) for optical fibre transmission systems to those found in copper and radio systems.

3.21 Justify the type of fibre employed for typical applications.
Applications: long-distance and short-distance links

3.22 Describe how optical fibres may be joined and terminated.

3.23 Describe the structure of fibre optic cables.

3.24 Explain the operating principles of Light Emitting Diodes (LEDs) as used for fibre optic transmitting devices.

3.25 Explain the operating principles of Semiconductor Laser Diodes (SLDs) as used for fibre optic transmitting devices.

3.26 Distinguish between the properties of the LED and the SLD.

3.27 Explain the operating principles of the P-type Intrinsic N-type (PIN) photo-diode as used for fibre optic receiving devices.

3.28 Explain the operating principles of the Avalanche Photo Diode (APD) as used for fibre optic receiving devices.

3.29 Distinguish between the properties of the PIN and the APD photo-diodes.

3.30 Explain, in relation to fibre optic transmission systems, what is meant by 'wavelength division multiplexing'.

3.31 Describe what is meant by 'Dense Wavelength Division Multiplexing' (DWDM) and how it may be achieved.

3.32 Investigate the characteristics of typical fibre optic transmission links identifying transmitting and receiving devices and the type of fibre used.

3.33 Investigate, and explain the function of, the range of test equipment used on fibre optic links.
Test equipment: optical power meters, optical time domain reflectometer

3.34 Explain safe working practices when working with optical fibres and semiconductor laser diodes.

3.35 Perform link budget equations in order to determine whether a given link is loss limited or dispersion limited.

022 Advanced Telecommunication Systems

04 Transmission systems

Introduction

The aim of this section is to enable the candidate to understand

a) the basic operation of the Asynchronous Transfer Mode (ATM)
b) the operation of the Plesiochronous Digital Hierarchy (PDH)
c) the operation of the Synchronous Digital Hierarchy (SDH) and the Synchronous Optical Network (SONET) systems
d) the transmission of ATM cells over SDH.

Notes:

1 It is suggested that about 34 guided learning hours should be given to this section.

Book list

Broadband Networking: ATM, SDH and SONET; Mike Sexton and Andy Reid.

Knowledge requirements

The instructor must ensure the candidate is able to:

4.1 Depict the Asynchronous Transfer Mode (ATM) protocol architecture model.

4.2 Depict a Synchronous Optical Network (SONET) / Synchronous Digital Hierarchy (SDH) frame structure.

4.3 Conduct Web and literature reviews on the International Telecommunication Union (ITU-T) standards, on SDH and on American National Standards Institute (ANSI) SONET standards.

4.4 Describe ATM as a streamlined packet transfer interface that uses fixed size packets.

4.5 Explain that ATM provides both real-time and non real-time services and Quality of Service (QoS) capabilities.

4.6 Depict and label an ATM protocol architecture model.

4.7 Briefly explain the function of each layer and plane.
Layer: ATM, ATM Adaptation Layer (AAL), physical layer, higher layer
Plane: management, control, user

4.8. Explain that ATM is designed to be able to transfer many different types of traffic simultaneously, including real-time flows such as voice, video, and bursty TCP flows.

4.9 Explain the function of the Cell Loss Priority (CLP) bit in the ATM frame header.

4.10 Explain the operation of ATM logical connections and their uses.
Connections: Virtual Channel Connections (VCCs), Virtual Path Connections (VPCs)

4.11 Describe the characteristics of VPCs and VCCs.

4.12 Describe the four classes of service carried by ATM
Service classes: A,B,C,D

4.13 Describe the structure of the Synchronous Transport Module level 1 (STM-1) frame.

4.14 Explain the function of the Administration Unit (AU) in the STM-1 frame.

4.15 Explain the function of the AU pointer.

4.16 Explain that ATM requires some form of transmission structure to transport ATM cells.
Structure: SDH

4.17 Explain the SONET/SDH specifications with reference to the hierarchies and frame formats and technologies employed.

4.18 Briefly explain how PDH can interface into SDH with reference to ITU-T standards G707, G708, G709.

4.19 Describe how the SDH-based physical layer imposes a structure on the ATM cell stream.

4.20 Identify the advantages of the SDH-based approach.

022 Advanced Telecommunication Systems

05 Routing and switching

Introduction

The aim of this section is to enable the candidate to understand the

a) layer 3 routing algorithms
b) layer 2 switching technology
c) standards and protocols associated with the above technologies.

Notes:

1 It is suggested that about 60 guided learning hours should be given to this section.

Book list

Designing Addressing Architectures for Routing and Switching (McMillan Network Architecture and Development); Howard C. Berkowitz.
IP Switching and Routing Essentials: Principles and Protocols for Delivering Data on the Internet; Stephen Thomas.
The Switch Book: The Complete Guide to LAN Switching Technology; Rich Seifert.

Knowledge requirements

The instructor must ensure the candidate is able to:

Routing

5.1 Describe in general terms the role of layer 3 routing and layer 2 switching in a computer network.

5.2 Describe routing algorithms and their implementation in networks.

5.3 Explain desirable properties for a routing algorithm.
Properties: correctness, simplicity, robustness, stability, fairness, optimality

5.4 State that there are link-state algorithms (also known as shortest path first algorithms) and distance vector algorithms and list the differences between them.

5.5 Explain that link-state algorithms send small broadcast updates, while distance vector algorithms send larger updates only to neighbouring routers.

5.6 Provide examples of distance vector algorithms.
Examples: Bellman-Ford, Ford-Fulkerson

5.7 Explain the drawbacks associated with distance vector algorithms and their solutions.
Drawbacks: routing loops, high demand on the wire

5.8 Define and provide examples of routing metrics.
Examples: path length, reliability, delay, bandwidth, load, communication cost

5.9 Explain the mechanism of network convergence.
Convergence: process of agreement, unified routing tables, optimised routes

5.10 Explain the International Standards Organisation (ISO) terms End Systems (ES) and Intermediate Systems (IS) and provide an example of each.
Example ES: Personal Computer (PC)
Example IS: router

5.11 State that Routing Information Protocol (RIP) is an example of a routing protocol that uses a distance vector algorithm.

5.12 Describe the methods deployed by RIP to maintain routing tables.

5.13 Identify the features included in RIPv2 which were absent in RIP.

5.14 Give examples of a link-state routing protocol.
Examples: Open Shortest Path First (OSPF), Request For Comment (RFC) (1247), Intermediate-System to Intermediate-System (IS-IS)

5.15 Describe the contrasts between the link-state routing protocol OSPF and the distance vector routing protocol RIP.

5.16 Explain how routers use link-state routing protocols to communicate network information to each other.

5.17 Describe the benefits of hierarchical routing.
Benefits: route summarisation, reduced routing tables

5.18 Describe an Autonomous System (AS) in the context of Internet working.

5.19 Declare that an AS utilises the Internal Gateway Protocol (IGP) for routing.

5.20 Describe the methods used to achieve AS to AS router communication.
Methods: Exterior Gateway Protocols (EGP), Autonomous System Boundary Routing (ASBR)

5.21 Describe the facilities provided by the Internet Control Message Protocol (ICMP) to communicate events between routers.
Events: DESTINATION UNREACHABLE, TIME EXCEEDED, SOURCE QUENCH

5.22 State that the performance of routers is expressed in packets per second (pps).
Performance: packet forwarding rate

Switching

5.23 Declare that a layer 2 switch is a high-speed multiport bridge.

5.24 Explain how switches create separate collision domains in a topology that deploys contention as the method for media access.
Topology: Ethernet
Contention: Carrier Sense Multiple Access with Collision Detection (CSMA/CD)

5.25 Declare that full-duplex communication is achievable when only one host is directly connected to a switch port.

5.26 Explain how switches achieve flow control.

5.27 Describe the different methods of switching and compare their advantages and disadvantages.
Methods: cut through, store-and-forward

5.28 Explain how loops can develop in a network with two or more switches connected together.

5.29 Discuss how the problems of loops are addressed.

5.30 Describe the process deployed by bridges and layer 2 switches to establish a loop-free network.

5.31 Declare that Virtual Local Area Networks (VLANs) constitute separate broadcast domains and that a router would be required to connect them.

5.32 Explain the advantages of using VLANs.
Advantages: simplifying moves and changes

5.33 State that VLANs can be port based or policy based.
Policy: Media Access Control (MAC) addresses, protocol type

5.34 Explain the function and operation methods of a layer 3 switching device.

5.35 Identify and describe the advantages and disadvantages of a MAC address based VLAN.
MAC address: 48 bit Ethernet Network Interface Card (NIC) physical address

5.36 Explain how VLAN information is propagated across connected LAN switches.

5.37 Declare that a router connected to a trunk port of a layer 2 switch to implement layer 3 routing is termed a router-on-a-stick.

5.38 State that a router-on-a-stick facility is only available to trunking protocol aware routers.

5.39 Define a switch backplane and its effect on the performance of a switch.

5.40 Define the term, non-blocking switch fabric.

022 Advanced Telecommunication Systems

06 Intelligent Networks (INs) and call management

Introduction

The aim of this section is to enable the candidate to understand the

a) issues relating to the revolution from Plain Old Telephone Systems (POTS) to the current INs
b) importance of INs for the present day telecommunication industry
c) function and operation of INs and call management systems.

Notes:

1 It is suggested that about 20 guided learning hours should be given to this section.

Book list

2000 IEEE Intelligent Networks Workshop; IEEE Consumer Electronics Society.
Intelligent Networks and New Technologies; N. Norgaard (Editor) and Villy Baek Iversen (Editor).
Signaling System #7; Travis Russell.

Knowledge requirements

The instructor must ensure the candidate is able to:

6.1 Draw a block diagram illustrating the components of an IN.

6.2 Draw a diagram illustrating the Signalling System No.7 (SS7) protocol stack and label the different parts.

6.3 Describe the limitations of the POTS.

6.4 Give a brief definition of an IN referencing service logic and switching equipment.

6.5 Describe an IN and the advantages offered by an IN.
Advantages: rapid deployment of services, vendor independence, standard interfaces, opportunities for non Regional Telephone Operators (RTOs) to offer services for increased network usage

6.6 Describe the advanced services that INs can offer.
Services: time-of-day routing, national and local rates, telephone voting, call centres, premium rates, counter traffic congestion, toll-free calling, toll wireline services, Call Line Identifier (CLI), Local Number Portability (LNP), personalised billing

6.7 Describe the technologies used in INs.
Technologies: (SS7), International Telecommunications Union (ITU)-T IN capability set

6.8 Describe the key features of the SS7 technology that facilitates the operation of INs.

6.9 Describe the components of the SS7 protocol stack and their functions.
Components: Transaction Capabilities Application Part (TCAP), Application Service Part (ASP), Signalling Connection Control Part (SCCP), Telephone User Part (TUP), Integrated Services Digital Network (ISDN) User Part (ISUP), Broadband ISDN User Part (BISUP), Message Transfer Part (MTP)

6.10 Describe the function of different types of signalling endpoints.
Types: Service Switching Point (SSP), Signal Transfer Point (STP), Service Control Point (SCP)

022 Advanced Telecommunication Systems

07 Internet Data Centres (IDCs)

Introduction

The aim of this section is to enable the candidate to understand

a) the importance of maintaining an optimised IDC
b) the tools and methods deployed to optimise the operation of an IDC.

Notes:

1 It is suggested that about 34 guided learning hours should be given to this section.

Book list

The CERT(R) Guide to System and Network Security Practices; Julia H. Allen.
Optimizing Bandwidth; Michele Jo Petrovsky.
Web Protocols and Practice: HTTP/1.1, Networking Protocols, Caching, and Traffic Measurement; Balachander Krishnamurthy and Jennifer Rexford.

Knowledge requirements

The instructor must ensure the candidate is able to:

7.1 Describe a basic IDC configuration, which includes redundancy and performance enhancing appliances.

7.2 Interpret performance data and graphs generated from an IDC.

7.3 Interpret vendor specification sheets.

7.4 Understand that in an IDC, rapid and consistent response times to client network requests are important, hence the need to be able to monitor IDC performance.

7.5 Identify a purpose for Application Service Level Agreements (ASLAs).
Purpose: measurable rights and obligations of customer and service provider

7.6 Identify the importance of Quality of Service (QoS) monitoring and reporting in relation to an IDC's traffic flow.

7.7 Describe the use of monitoring and shaping appliances to generate report data for specific network traffic.
Appliances: traffic shapers, application shapers

7.8 Explain that traffic shapers and application shapers provide a detailed picture of the kinds of traffic an IDC is processing and how fast it is moving into and out of the IDC.

7.9 Understand that in the choice of appliances for traffic and appliance shapers, it is important that one ensures that, apart from reporting and analysing the data, it will permit the control of the traffic for maintaining an optimised IDC.

7.10 Explain the benefits of caching servers or caching appliances, deployed in key locations.
Benefits: serves selected data faster, eliminates the need to download locally stored and current data from the IDC Web servers, more bandwidth available for data that is updated or unique to a selected web page

7.11 Describe the benefits of Web caching.

7.12 Describe the benefits of caching appliances in relation to protocol and communications support and their suitability for deployment in diverse environments.

7.13 Explain the purpose of intelligent traffic management and load-balancing technologies.
Purpose: facilitate speed and reliability to IDC applications

7.14 List and describe the different load-balancing technologies.

7.15 Explain how integrating an encryption/decryption appliance, improves data throughput in an IDC.
Appliance: hardware based encryption/decryption processing

7.16 Identify the current and emerging technologies that provide viable backbone solutions for the service provider IDC.
Technologies: high speed, reliable connections

7.17 Describe how service providers, supporting multiple IDCs, can improve their inter-IDC connectivity performance.

7.18 State the technologies, which are designed to improve performance and reliability of application servers in IDCs and how this is achieved.
Technologies: Redundant Array of Independent Drives (RAIDs), fibre channel

7.19 Describe how server clustering can be deployed for performance enhancement and/or fail over protection in an IDC.

7.20 Identify open source examples of clustering technology.
Examples: Beowulf, Piranha

7.21 State a potential problem encountered with cluster implementation.
Problem: single point of failure

022 Advanced Telecommunication Systems

08 Network management

Introduction

The aim of this section is to enable the candidate to understand the functional areas of network

a) fault management
b) configuration management
c) accounting management
d) performance management
e) security management.

Notes:

1 It is suggested that about 32 guided learning hours should be given to this section.

Book list

Network Troubleshooting Tools (O'Reilly System Administration); Joseph D. Sloan.
Practical Network Design, Management and Troubleshooting; J. Scott Haugdahl.
Snmp, Snmpv2, Snmpv3, and Rmon 1 and 2; William Stallings.

Knowledge requirements

The instructor must ensure the candidates are able to:

8.1 Interpret and respond to events and traps as they occur on networks through the use of network monitoring software.

8.2 Analyse reports generated by network monitoring software.

8.3 List and explain the function of the components that comprise the Internet management model in the context of the Simple Network Management Protocol (SNMP).
Components: network elements, agents, managed object, Management Information Base (MIB), syntax notation, Structure of Management Information (SMI), Network Management Stations (NMSs), parties, management protocol

8.4 Draw a block diagram to represent the Internet management model, which includes all its components.

8.5 Explain that interactions between the NMS and managed devices can be any one of four different types of commands.
Commands: reads, writes, traversal operations, traps

8.6 Describe parameters that can be monitored.
Parameters: router buffer usage, packet loss, Central Processing Unit (CPU) temperature

8.7 Explain that threshold management is the mechanism that enables operators to identify network conditions that have crossed a specified level so as to help predict network problems.

8.8 Explain that security problems can be divided into four intertwined areas.
Areas: secrecy, authentication, non-repudiation, integrity control

8.9 Explain that passwords are basic ways of controlling access to resources.

8.10 Explain the process of cryptography in the context of transferring data.

8.11 Discuss Caesar's Cipher, introducing the concept of keys and explain that it is a simple example of encryption.

8.12 State that there are two types of cryptosystems.
Types: symmetric, asymmetric

8.13 Explain that symmetric key cryptography, also known as secret key cryptography, utilises the same key to encrypt and decrypt data, while asymmetric or public key cryptography utilises only one private key holder and many public key holders.

8.14 Explain briefly digital certificates and certificate authorities.

8.15 Identify a widely used standard for defining digital certificates.
Standard: X.509

8.16 Explain that Public Key Infrastructure (PKI) is a system of digital certificates, certificate authorities and other registration authorities that verify and authenticate the validity of each party involved in an Internet transaction.

8.17 Demonstrate how e-mail can be sent securely using cryptography.

8.18 Explain that digitally signed e-mails can deter e-mail viruses.

8.19 Declare the need to implement antiviral software and the importance of having it updated regularly to protect vulnerable systems.

Assessment

Test Specification for Written Paper
Advanced Telecommunication Systems (2730-03-022)

This is a written examination paper lasting three hours with ten questions. Candidates must answer **all** questions.

The examination paper will cover the knowledge specifications:

Topic		**Approximate % examination weighting**
01	Transmission Control Protocol / Internet Protocol (TCP/IP)	13
02	International standards, recommendations and regulatory authorities	7
03	Optical fibre systems	20
04	Transmission systems	11
05	Routing and switching	20
06	Intelligent Networks (INs) and call management	7
07	Internet Data Centres (IDCs)	11
08	Network management	11

023 Advanced Radio Systems

Introduction

The aim of this unit is to enable the candidate to:

a) describe the principles and concepts involved in radio communication systems
b) describe the properties and applications of mobile and fixed radio systems.

Notes:

1 It is suggested that about 150 guided learning hours should be given to this unit.

2 It is recommended that the guided learning hours should be allocated as follows:

Radio frequency propagation and antennas in the very high frequency (v.h.f.) bands and above	25 hours
Radio transmitters and receivers	30 hours
The Universal Mobile Telephone System (UMTS) and Third Generation (3G) mobile phones	55 hours
Microwave radio relay and satellites systems	25 hours

Book List

Advanced Electronic Communications Systems; Wayne Tomasi.
Radio Systems Technology; D. C. Green.
UMTS Network; Heikki Kaaranen, Naghian Siamak and Lauri Aitinen.
WCDMA for UMTS; Harri Holma.

Practical competences

The candidate must be able to do the following:

1.1 Evaluate the current situation regarding the deployment of new generation (2.5G) mobile networks.

1.2 Investigate the current situation regarding the deployment of the proposed third generation (3G) mobile networks.

Knowledge requirements

The instructor must ensure the candidate is able to:

Radio frequency propagation and antennas in the v.h.f. bands and above

1.3 Explain the affects of the earth's atmosphere on space wave radio signals.
Affects: absorption, refraction

1.4 Explain what is meant by 'ducting' and its causes.

1.5 Describe the three basic causes of fading of radio signals on the v.h.f. bands and above.
Causes: absorption, free-space loss, multipath (Rayleigh)

1.6 Explain what is meant by the term 'diffraction' of space wave radio signals and its causes.

1.7 Describe the factors affecting the propagation of radio signals inside buildings.

1.8 Explain the importance of the Carrier-to-Interference ratio (C/I) in radio communication systems.

1.9 Explain the causes of interference to radio signals at v.h.f. and above.
Causes: co-channel, adjacent-channel, intermodulation

1.10 Explain the need for employing diversity reception techniques in radio systems.

1.11 Describe the following methods of diversity reception:

i) Frequency diversity

ii) Space diversity

iii) Polarisation diversity.

1.12 Explain what is meant by antenna gain.

1.13 Explain what is meant by the beamwidth of an antenna.

1.14 Explain what is meant by the effective length of an antenna.

1.15 Explain what is meant by the radiation resistance of an antenna.

1.16 Explain what is meant by Effective Isotropic Radiated Power (EIRP).

1.17 Explain the operation of parabolic dish antenna when used on ultra high frequency (u.h.f.) bands and above.

1.18 Determine the gain of a dish antenna given the dish diameter and frequency (or wavelength) of operation.

1.19 Explain what is meant by the effective aperture of a parabolic dish antenna.

1.20 Explain what is meant by free space path loss and calculate the 'loss' given the distance in km and the frequency (or wavelength) of operation.

Radio transmitters and receivers

1.21 Explain the need for carrier frequency stability in radio transmitters.

1.22 Describe frequency synthesisers and their application in radio transmitters and receivers.

1.23 Explain the functions of a final stage power amplifier in a radio transmitter.

1.24 Describe the difference between low-level and high-level modulation.

1.25 Sketch the block diagram of a simple AM transmitter and describe the function of each stage.

1.26 Sketch the block diagram of a simple FM transmitter and describe the function of each stage.

1.27 Explain the methods for eliminating harmonics in radio transmitters.

1.28 Describe the need for pre-emphasis in frequency-modulated transmitters.

1.29 Explain why the class of bias used is an important factor in radio transmitters.

1.30 Justify the use of class C bias for mobile radio transmitters.

1.31 Evaluate the requirement for power level control in radio transmitters which are

i) fixed position

ii) mobile

iii) hand-held.

1.32 Explain why the dual conversion superheterodyne process is normally used for communications receivers designed for use on the high frequency (h.f.) bands and above.

1.33 Sketch the block (system) diagram of a double superheterodyne receiver designed to receive amplitude modulated signals and explain the function of each stage.

1.34 Sketch the block (system) diagram of a double superheterodyne receiver designed to receive frequency modulated signals and explain the function of each stage.

1.35 Evaluate the major differences in the design of the receivers in 1.33 and 1.34.

1.36 Explain what is meant by noise figure (noise factor) in communication receivers.

1.37 Calculate the noise figure given the values of the input and output signal and noise powers.

1.38 Calculate the noise figure for a cascaded series of stages given the noise figure and power gain for the individual stages.

1.39 Explain why it is important that the first stage of a highly sensitive radio receiver is designed for low internal noise properties.

1.40 Explain why it is important that the noise figure should be as low as possible.

1.41 Evaluate the need for the following subsystems in communications receivers:

i) Squelch

ii) Noise limiters

iii) Automatic Gain Control

iv) De-emphasis.

1.42 Explain the need for diplexers in radio transceivers and how duplex operation may be achieved with the aid of diplexers.

1.43 Explain what is meant by spread spectrum (also known as Code Division Multiple Access) techniques in radio communication.

1.44 Describe the following forms of spread spectrum techniques:

i) Frequency hopping

ii) Time hopping

iii) Direct sequence.

The UMTS and 3G mobile phones

1.45 Explain that International Mobile Telecommunications – 2000 (IMT-2000) was the ITU vision of a global federation of compatible fixed and mobile telecommunications systems.

1.46 Explain why the introduction of packet switching techniques in the form of the General Packet Radio Service (GPRS) into existing GSM networks, can be regarded as the first step in the evolution towards third generation (3G) networks.

1.47 Describe the introduction of multimedia services as a key commercial driver for the evolution of 3G systems.

1.48 Describe the implementation of Enhanced Data rates for GSM Evolution (EDGE), as a legitimate route to the provision of 3G services for those existing TDMA network operators who did not secure additional 3G spectrum licenses.

1.49 Explain why Code Division Multiple Access (CDMA) systems were the dominant choice of the proposals submitted to the ITU.

1.50 State that WCDMA was the European proposal for the IMT-2000 air interface.

1.51 Describe how in CDMA – Direct Sequence (CDMA-DS), narrowband information signals are multiplied by unique high-speed codes, effectively spreading the signal bandwidth.

1.52 Define the concept of orthogonality as applied to the Orthogonal Variable Spreading Factor (OVSF) codes used in the UMTS.

1.53 Explain why the retention of orthogonality is crucial to the dispreading process.

1.54 Describe how a code tree can be used to generate multiple OVSF codes and the limitations imposed by the use of higher order codes.

1.55 Explain the principle behind multiple code transmission and reception.

1.56 Explain the reasons for scrambling in the UMTS air interface.

1.57 Define, and differentiate between, the concepts of spreading factor and processing gain.

1.58 Explain how multiple path propagation can be used to advantage in CDMA systems.

1.59 Describe the operation of the Radio Activated Key Entry (RAKE) receiver.

1.60 Explain why there is a need for rigid power control in CDMA systems and how it is implemented in the UMTS air interface.

1.61 Explain why error protection is crucial in the UMTS air interface.

1.62 Describe the different types of error protection used in the UMTS air interface.

1.63 Discuss UMTS network planning making reference to the following factors:

i) Single frequency re-use

ii) OVSF code availability

iii) Service availability/ QoS

iv) Mutual interference

v) Cell breathing.

1.64 Describe the types of channel which exist in UMTS systems.
Channel types: logical, transport and physical

1.65 Explain how logical, transport and physical channels are mapped together.

1.66 Describe the composition of the frame structures of the major physical channels in UMTS.

1.67 Describe the air interface protocol stacks for Release 99 (R99) in the Circuit Switched (CS) domain and the Packet Switched (PS) domain (for both the user and control plane).

1.68 Explain the functionality of the following protocols:

i) Radio Link Control (RLC)

ii) Medium Access Control (MAC)

iii) Packet Data Convergence Protocol (PDCP)

iv) Broadcast/Multicast Control (BMC).

1.69 With the aid of a diagram, describe the composition and functionality of the UMTS Terrestrial Radio Access Network (UTRAN), including the associated interfaces.

1.70 Explain the concept of macro diversity and the advantages it provides.

1.71 With the aid of a diagram, describe the composition and functionality of R99 UMTS Core Network (CN), including the major interfaces.

1.72 Describe the responsibilities of the CN.
Responsibilities: subscriber connection, subscriber management, network management.

1.73 Describe the responsibilities of all R99 CN components.

1.74 Explain the advantages and disadvantages of separate packet switched and circuit switched domains in the R99 CN.

1.75 Describe the GPRS Tunnelling Protocol (GTP), and the interfaces where it is implemented.

1.76 Describe the differences between the R99, Phase 4 and Phase 5 UMTS network architectures.

1.77 Identify the transmission and addressing systems used with UMTS, and the rationale behind their being chosen.

1.78 Describe circuit grooming, and the possible transmission topologies.

1.79 Describe the security threats that exist in UMTS, and how network operators can guard against them.
Security threats: unauthorised access to data, threats to integrity, denial of service, unauthorised access to services, repudiation.

1.80 State the factors to be taken into account when implementing a 3G network.
Factors: financial restrictions, environmental/health restrictions, licensing conditions, applications (varied and wanted), learning from the experience of other operators, technical limitations

Microwave radio relay and satellites systems

1.81 Sketch the block (system) diagram of a microwave radio (line-of-sight) repeater system and explain the function of each stage.

1.82 Explain the importance of the Carrier-to-Noise density ratio (C/No)

1.83 Explain the importance of the Energy of Bit-to-Noise density ratio (Eb/No) and its relevance to the Bit Error Rate (BER).

1.84 Carry out calculations for 1.82 and 1.83.

1.85 Explain what is meant by 'system threshold' in radio systems.

1.86 Carry out calculations for 1.85.

1.87 Calculate link budgets equations for microwave radio relay systems.

1.88 Explain what is meant by the term 'fade margin' and describe its importance when carrying out link budgets.

1.89 Evaluate the advantages and disadvantages of communicating by means of geosynchronous satellites rather than satellites in low earth orbits.

1.90 Explain why the angle of elevation is an important factor in satellite communications.

1.91 Evaluate the reasons for the popularity of the 6/4 GHz bands for satellite communications purposes.

1.92 Explain what is meant by equivalent noise temperature in satellite communication systems.

1.93 Explain the importance of the G/T ratio to satellite communication systems.

1.94 Calculate link budget equations for satellite communication systems.

1.95 Describe the multiplexing and multiple access arrangements for communications satellites.

1.96 Describe satellite subsystems
Subsystems: attitude and orbit control, telemetry tracking and command, power system, communications subsystems, spacecraft antennas.

1.97 Explain how a satellite maintains its attitude relative to the earth's surface.

1.98 Sketch the block (system) diagram of a satellite transponder and explain the function of each stage.

1.99 Describe typical earth station equipment.
Equipment: antenna, low noise receiver, high power transmitter, tracking, terrestrial network interface

1.100 Evaluate the options in satellite launch vehicles and the agencies responsible.

1.101 Evaluate the role of Very Small Aperture Satellites (VSATs) in national/international communication.

Assessment

Test specification for Written Paper Advanced Radio Systems (2730-03-023)

This is a written examination paper lasting three hours with ten question. Candidates must answer **all** questions.

The examination paper will cover the knowledge specifications:

Topic	**Approximate % examination weighting**
Radio frequency propagation and antennas in the v.h.f. bands and above	20
Radio transmitters and receivers	25
The UMTS and 3G mobile phones	35
Microwave radio relay and satellites systems	20

Practical Assignments – Advanced Radio Systems Practice

Assignment 024/1: Examination of 2.5G and 3G telecommunications systems

1 OBJECTIVE REFERENCES

2730-03-023: 1.1 – 1.2

2 PREPARATION

2.1 *Location of the test*

The training centre or other venue where supervision and appropriate facilities are available.

2.2 *Requirements*

Standard material relevant to the syllabus.

2.3 *Instructor Notes*

The aim of this assignment is to test the candidates' knowledge and understanding of the current situation regarding the deployment and usage of 2.5G and 3G telecommunications systems, and an understanding of the implementation issues facing network operators.

Instructors should interpret the assignment in the context of the prevailing situation effecting national and regional networks.

3 CANDIDATES INSTRUCTIONS

3.1 Ensure that you understand all the requirements of the assignment and follow them precisely. If you are in any doubt ask the instructor. The results of your investigations are to be written up in the form of a report which must be handed in to your instructor by the agreed deadline.

3.2 Your task is to conduct a research based assignment on the main practical aspects of 2.5G and 3G telecommunications systems. You will need to investigate and evaluate the current status of existing networks and the planned developments over the next few years.

Your report should cover the following areas:

3.2.1 The current position regarding the deployment of 2.5G systems in national cellular networks.

3.2.2 Details of existing 2.5G networks and the data rates provisioned.

3.2.3 Details of the main applications carried. Applications to be considered include: multimedia messaging, location services, e-commerce and gaming.

3.2.4 Any technical challenges which currently exist in the deployment of these systems and/or applications. Challenges should include: technical, environmental, safety, marketing and financial issues.

3.2.5 How 2.5G high speed data services are being marketed today. Factors that should be taken into account should include marketing strategies based on segmentation groups, multimedia services and billing.

3.2.6 The current position regarding the deployment of 3G systems in national cellular networks.

3.2.7 How 3G services are being marketed today.

3.2.8 Details of the main 3G applications.

3.2.9 Details of key partners working with the licence holders in order to provision 3G applications.

3.2.10 The technical challenges that are likely to exist in the deployment of 3G systems. Challenges should include: classes of terminal (eg PDA, voice centric, smart phones).

3.2.11 Details of efforts being made in order to facilitate global roaming. Efforts to include: multi-mode/multi-band terminals, control by 3GPP/3GPP2/OHG.

3.2.12 Details of any future enhancements/advancements to existing telecommunication systems which are on the horizon. Details should include advances in: systems, applications, data rates, architecture.

4 MARKING

4.1 Work handed in to the instructor on or before the agreed deadline. [ ]

4.2 Candidates report includes: ( )

4.2.1 Current position regarding the deployment of 2.5G systems in national cellular networks. ( )

4.2.2 Details of existing 2.5G networks and the data rates provisioned. ( )

4.2.3 Details of the main applications carried. Applications to be considered include: multimedia messaging, location services, e-commerce and gaming. ( )

4.2.4 Any technical challenges which currently exist in the deployment of these systems and/or applications. Challenges should include: technical, environmental, safety, marketing and financial issues. ( )

4.2.5 How 2.5G high speed data services are being marketed today. Factors that should be taken into account should include marketing strategies based on segmentation groups, multimedia services and billing. ( )

4.2.6 The current position regarding the deployment of 3G systems in national cellular networks. ( )

4.2.7 How 3G services are being marketed today. ( )

4.2.8 Details of the main 3G applications. ( )

4.2.9 Details of key partners working with the licence holders in order to provision 3G applications. ( )

4.2.10 The technical challenges that are likely to exist in the deployment of 3G systems. Challenges should include: classes of terminal (eg PDA, voice centric, smart phones). ( )

4.2.11 Details of efforts being made in order to facilitate global roaming. Efforts to include: multi-mode/multi-band terminals, control by 3GPP/3GPP2/OHG. ( )

4.2.12 Details of any future enhancements/advancements to existing telecommunication systems which are on the horizon. Details should include advances in: systems, applications, data rates, architecture. ( )

5 ASSIGNMENT COMPLETION

The candidate will have satisfactorily completed this assignment if successful in all items marked with [ ] and at least nine of the items marked with ( ).

A period of seven days must elapse before an unsuccessful candidate may retake this assignment.

025 Software Engineering

Introduction

The aim of this unit is to enable the candidate to

a) demonstrate a high level of competency in the creation of a computer programme
b) manage and document a software development.

Notes:

1 It is suggested that about 150 guided learning hours should be given to this unit.

2 It is recommended that the guided learning hours should be allocated as follows:

The need for software engineering – software process	7 hours
Software specification – requirements analysis	20 hours
Software design and implementation – design methodology	12 hours
Programming practice and software tools	22 hours
Software validation – testing	18 hours
Programming languages	56 hours

Book list

The Formal Semantics of Programming Languages; Glynn Winskel.
Object-Oriented Software Engineering; Ivar Jacobson.
PHP and MySQL Web Development; Luke Welling, Laura Thompson.
A Programmer's Guide to Software Development (2nd edition); Keith Haviland, Dina Gray, Ben Salama, Gina Gray.
The Structure of Typed Programming Languages; David A. Schmidt.

Practical competences

The candidate must be able to:

1.1 Design and implement a software solution.

1.2 Plan, manage and fully document the development process of a software solution.

1.3 Access sources of reference accurately.

Knowledge requirements

The instructor must ensure the candidate is able to:

The need for software engineering – software process

1.4 Describe the term software crisis.

1.5 Describe the problems associated with large scale software development.

1.6 Describe, with the aid of a diagram, the waterfall model of software development in terms of comprising

i) specification/requirements analysis

ii) design

iii) implementation

iv) testing

v) maintenance.

1.7 State the importance of documentation.

Software specification – requirements analysis

1.8 Distinguish between requirements definition as a user view of the system and requirements specification as a formal technical view.

1.9 Discuss why both system views outlined in 1.8 are needed.

1.10 Describe the concept of systems modelling.

1.11 Explain the shortcomings of natural language specification.

1.12 Describe the notion of prototyping.

1.13 List and describe the benefits of formal specification.

1.14 Describe the difficulties that may be found in distinguishing between analysis and design.

1.15 Explain why finite state machines are often used to model real-time systems.

1.16 Draw a simple state diagram.

Software design and implementation – design methodology

1.17 Describe the phrase top down design.

1.18 Define the terms cohesion and coupling.

1.19 Explain why cohesion and loose coupling are desirable.

1.20 Differentiate between object-orientated design and function-oriented design.

1.21 Describe what a given simple low level design (given in pseudo-code or Jackson procedural notation) is intended to do.

1.22 Design, using pseudo-code or Jackson procedural notation, a simple program.

Programming practice and software tools

1.23 Describe the relative merits of top-down and bottom-up development.

1.24 Give examples of good programming practise in terms of naming and layout.

1.25 Describe the term portability.

1.26 Describe the term portability as applied to software components.

1.27 Describe the difficulties which may be encountered in attempting to achieve portability.

1.28 Define the term CASE.

1.29 Describe the typical CASE workbench facilities.

1.30 Define the term IPSE.

1.31 List the advantages of using a software engineering environment.

1.32 Describe, with the aid of a diagram, the structure of an IPSE.

1.33 Define the term WIMP interface.

1.34 Define the terms:

i) Computational model

ii) Computation

iii) Program

iv) Programming language

v) Syntax

vi) Semantics

vii) Pragmatics

Software validation – testing

1.35 Differentiate between the terms validation and verification.

1.36 Sketch a diagram of the stages of testing.

1.37 Describe the relative merits of top-down and bottom-up testing.

1.38 Describe the concepts of black-box and white-box testing.

1.39 Describe the term equivalence partitioning.

1.40 Differentiate between static analysis and dynamic analysis.

1.41 Describe the particular problems of testing real-time telecommunications systems.

1.42 Describe the roles adopted by participants in a program inspection.

1.43 Draw the typical stages in the inspection process.

Programming languages

1.44 Differentiate between scripting and system languages.

1.45 List at least three scripting languages.

1.46 List at least three system languages.

1.47 Identify and briefly describe at least one programming language from each of the following programming paradigms:

i) Object-Orientated

ii) Functional

iii) Logical

iv) Visual

v) Scripted.

1.48 Recognise and describe the function of Object Orientated Programming (OOP) components.
Components: objects, inheritance, relationship, delegation, class

1.49 Identify and discuss the merits of at least three OOP languages.

1.50 Differentiate between and justify the use of server-side and client-side scripting.
Server-side scripting: Perl Hypertext Pre-Processor (PHP)
Client-side scripting: Javascript

1.51 Justify the need for a Unified Modelling Language (UML).

1.52 Define the term 'platform independent'.

1.53 Identify a language that is considered to be platform independent.

1.54 Describe in detail, a method of obtaining platform independence.
Method: Java Virtual Machine (JVM)

1.55 Justify the development and implementation of platform independent programmes.

1.56 Justify the introduction of Standard Generalised Markup Language (SGML).

1.57 Describe the fundamental differences between given SGML sub-sets.
Sub-sets: Hypertext Markup Language (HTML), eXtensible Markup Language (XML)

1.58 Understand the general design of the Unix operating system including the kernel, file system and the shell.

1.59 Explain the function of the Unix kernel.

1.60 Describe a method of programming in the Unix environment.
Method: system calls

1.61 Explain the file concept of Unix.

1.62 Describe the file access methods deployed by Unix.

1.63 Understand that Unix does not distinguish between different types of file.

1.64 Explain directories and pathnames. File ownership and permissions and Unix commands for manipulating these including creating, changing permissions and deleting files.

1.65 Explain a process in Unix terminology and the meaning of 'interprocess communication'.

1.66 Give examples of the fundamental Unix file access primitives including 'open', 'create', 'close', 'read' and explain their functions in writing Unix programs.

1.67 Explain file descriptors and how they are used in Unix programming.

1.68 Identify the three files the Unix system automatically opens to execute programmes and describe their function

1.69 Understand the Unix standard subroutine libraries, including the 'Standard I/O Library' and provide examples of constituent routines.
Constituent routines: getchar, printf

Assessment

Test specification for Written Paper Software Engineering (2730-03-025)

This is a written examination paper lasting three hours with ten question. Candidates must answer **all** questions.

The examination paper will cover the knowledge specifications:

Topic	**Approximate % examination weighting**
The need for software engineering – software process	6
Software specification – requirements analysis	14
Software design and implementation – design methodology	9
Programming practice and software tools	18
Software validation – testing	14
Programming languages	39

Practical Assignments – Software Engineering Practice

Practical assignment 026/1: Software Engineering

1 OBJECTIVE REFERENCES

2730-03-025: 1.1 – 1.3

2 PREPARATION

2.1 *Location of the test*

The training centre or other venue where supervision and appropriate working conditions will be provided

2.2. *Requirements*

Computer.

Printer.

Appropriate software to write programs.

2.3 *Instructor notes*

The aim of this assignment is to demonstrate a high level of competency in the creation of a computer programme and to manage and document a software development project.

The candidate should submit a suggestion for the design and production of a computer program. The suggestion should be innovative and present a challenge to the candidate.

The choice of programming languages has to be agreed with the instructor and should include the use of at least one Object Orientated Programming (OOP) language and one scripting language.

The project outcome should be of benefit to an organisation, people with specific needs, or be of commercial value.

The aims and objectives of the developed software have to be clearly formulated at the start of the assignment.

The timescale for this assignment is likely to extend well beyond the normal three hour period allocated to other assignments. Instructors are encouraged to issue this assignment at an early stage in the teaching of Software Engineering (2730-03-25). A realistic deadline should be set for the handing in of the assignment.

The writing up of this assignment may be done outside the normal classroom session.

3 CANDIDATES' INSTRUCTIONS

In this assignment you are required to design and produce a software solution for an office, a commercial organisation, or of benefit to the general public. Your choice of languages used for the project should include at least one Object Orientated Programming (OOP) language and one scripting language.

You are advised to read the instructions carefully before commencing any work. Ensure that you understand all instructions and follow them precisely. If you are in any doubt ask your instructor.

3.1 Submit a suggestion for your software solution to your instructor.

3.2 Once your instructor has accepted your suggestion, write a brief appraisal of your assignment. Your appraisal should include a list of activities required to achieve your solution and the timeframe. You must hand in the appraisal to your instructor before progressing with the assignment.

3.3 Produce documentation clearly outlining every stage of program development.

3.4 Document the testing stage of the program.

3.5 Show how to implement the solution.

3.6 Compile all documents into a report.

3.7 Present your solution to the class. The presentation should last between 10 and 15 minutes.π

3.8 Sign all documentation and hand it in to your instructor by the agreed deadline.

4 MARKING

4.1	Program suggestion submitted to the instructor.	[ ]
4.2	Appraisal written and handed in to the instructor.	[ ]
4.3	Documentation written to outline each stage of development.	[ ]
4.4	Testing stage documented.	[ ]
4.5	Solution implemented.	[ ]
4.6	Report compiled.	[ ]
4.7	Solution presented to the class.	[ ]
4.8	All documentation signed and handed in to the instructor.	[ ]

5 ASSIGNMENT COMPLETION

The candidate will have satisfactorily completed this assignment if successful in all items marked with a [ ].

A period of seven days must elapse before an unsuccessful candidate may retake this assignment.

027 Advanced Mathematics 2

Introduction

The aim of this unit is to enable the candidate to

a) advance and broaden the understanding of mathematics
b) acquire additional mathematical knowledge (not mandatory) for application to the Advanced Diploma option units in the topic areas of programming, radio, satellites and mobile phones.
c) gain sufficient mathematical knowledge to proceed to the second year of a telecommunications or related degree course after successful completion of the Advanced Diploma.

Notes:

1 The subjects in this unit would benefit if an integrative approach is used.
2 Where possible, it is expected that worked examples will be selected to represent programming, radio, satellites and mobile phones problems.
3 It is suggested that about 60 guided learning hours should be given to this unit.

Book list

Modern Engineering Mathematics (3rd edition); G. James.

Knowledge requirements

The instructor must ensure that the candidate is able to:

Further calculus

1.1 Differentiate functions y of the form

e^{ax} and $\log_e ax$

1.2 Differentiate simple functions in the form of a product, a quotient and a function of a function.

1.3 Derive the condition for maximum power dissipation in a variable external load R as obtained from the equation

$P = E^2R / (R + r)^2$ using $dP / dR = 0$

1.4 Integrate functions of the form

$y = ae^{bx}$

1.5 Estimate areas under curves using the Simpson rule.

1.6 Use a simple algebraic or trigonometric substitution to reduce an indefinite integral to standard form.

1.7 Evaluate a definite integration by substitution using either the original or the modified limits.

1.8 Use the integration by parts formula to integrate, with or without limits, expressions of the form

i) $ax\, e^{bx}$

ii) $ax \sin bx$

iii) $ax^2 \log_e x$

1.9 Use integration by parts twice to integrate expressions such as

$e^{ax} \sin bx$ and $ax^2 \cos bx$

1.10 State Maclaurin's theorem.

1.11 Determine the Maclaurin series for

i) $\sin x$

ii) $\cos x$

iii) $\log_e (1 + x)$

iv) $(1 + x)^n$

1.12 Deduce the Maclaurin series for

$\log_e (1 - x)$ and $\log_e [(1 + x) / (1 - x)]$

Series

1.13 Expand expressions of the form $(1 + x)^n$ for negative or fractional values of n and hence determine for each case the restrictions to be placed on x to ensure convergence.

1.14 Use the binomial theorem to expand

$1 / (1 \pm x)$ and $1 / (1 \pm x^2)$.

1.15 Use the binomial series to estimate the effects on the subject of a power-law formula of small percentage changes in the independent variables.

1.16 Deduce a general expression for the n^{th} term of a geometric progression having first term a and common ratio r.

1.17 Evaluate the sum to n terms of a geometric progression using the formula

$S_n = a (1 - r^n) / (1 - r)$

Further complex numbers

1.18 State that $\cos \theta + j \sin \theta$ can be expressed in the form $e^{j\theta}$

1.19 Deduce that $\cos \theta - j \sin \theta = e^{-j\theta}$

1.20 Derive de Moivre's theorem for all negative and fractional powers.

1.21 Use de Moivre's theorem to determine powers and roots of a complex number.

Partial fractions

1.22 State that the numerator of a compound expression must be of at least one degree less than the denominator in order for the expression to be split into its partial fractions.

1.23 Subdivide a compound expression into its partial fractions in the three distinct denominator cases of linear, repeated linear and non-factorisable quadratic.

Determinants and matrices and their use in solving simultaneous equations

1.24 Evaluate a second and a third order determinant.

1.25 Solve a system of three simultaneous linear equations in three unknowns using Cramer's rule.

1.26 Define the order, mxn, of a matrix and state that, when $m = 1$ the matrix is a row vector, and when $n = 1$ the matrix is a column vector.

1.27 Calculate the sum and difference of two matrices of the same order.

1.28 Determine the product of two $3x3$ matrices.

1.29 Explain why two matrices of unequal order may be multiplied providing the number of columns of the matrix on the left equals the number of rows of the matrix on the right.

1.30 Determine the product of an *mxn* with an *nxp* matrix to give an *mxp* matrix, with *m*, *n* and *p* small positive integers.

1.31 State that a square matrix *A* can be evaluated as a determinant, *det* (*A*).

1.32 Define the minor and cofactor of an element of the determinant of a matrix.

1.33 Define the transpose and adjoint (adj) of a matrix.

1.34 Define the inverse A^{-1} of a square matrix

A as *adj (A) / det (A)*

and determine the inverse for a non-singular *3x3* matrix.

1.35 Write a system of three simultaneous linear equations in three unknowns in matrix form $Ax = b$ and show that the solution is

$x = A^{-1} b$

1.36 Determine, for a system of three simultaneous linear equations, the three unknowns as the solution vector

$x = A^{-1} b$

Laplace transforms and their use in solving differential equations

1.37 Define the Laplace transform of $x(t)$ and state the common notations

$\bar{x}$, $X(s)$ and $L\{x(t)\}$

1.38 Use the table of standard transforms to determine the transforms of given functions.

1.39 Derive the Laplace transform of

$x(t)\, e^{-at}$ *as* $X(s + a)$ (shift theorem)

1.40 Define the inverse Laplace transform

$x(t) = L^{-1}\{X(s)\}$

1.41 Determine inverse transforms of simple forms using a table of standard transforms.

1.42 Determine the inverse Laplace transforms of partial fraction expressions using a table of standard transforms, by completing the square where necessary.

1.43 Determine the transform of each term of a first or a second order differential equation having constant coefficients and given initial conditions.

1.44 Obtain an expression for *X (s)* from the transformed differential equation.

1.45 Write the expression for *X (s)* in partial fractions where necessary and arrange in the form of standard transforms.

1.46 Determine the inverse transform for each term arising from partial fractions and deduce the particular solution of the first or second order differential equation.

Assessment

Test specification for Written Paper Advanced Mathematics 2 (2730-03-027)

This is a written examination paper lasting three hours with ten questions. Candidates must answer **all** questions.

The examination paper will cover the knowledge specifications:

Topic	Approximate % examination weighting
Further calculus	20
Series	10
Further complex numbers	10
Partial fractions	10
Determinants and matrices and their use in solving simultaneous equations	25
Laplace transforms and their use in solving differential equations	25

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Appendix A

Acronyms and Abbreviations

2G	Second Generation
3G	Third Generation
AAL	ATM Adaption Layer
AAS	Automatic Announcement Subsystem
ABR	Automatic Bit Rate
ACR	Attenuation-to-Crosstalk Ratio
ADM	Add and Drop Multiplexer
ADSL	Asymmetric Digital Subscribers Line
a.f.	audio frequency
AM	Amplitude Modulation
ANSI	American National Standards Institute
APD	Avanlanche Photo Diode
ARQ	Automatic Repeat Request
AS	Autonomous System
ASBR	Autonomous System Boundary Routing
ASCII	American Symbolic Code for Information Interchange
ASLA	Application Service Level Agreement
ASP	Application Service Part
ATM	Asynchronous Transfer Mode OR Automatic Teller Machine
AUC	Authentication Centre
BCD	Binary Coded Decimal
BD	Building Distributor
BER	Bit Error Rate
BISUP	Broadband ISDN User Part
BJT	Bipolar Junction Transistors
BMC	Broadcast / Multicast Control
bps	bits per second
BSC	Base Station Controller
BT	Burst Tolerance
BTS	Base Transceiver Station
C/No	Carrier-to-Noise Density Ratio
CBR	Constant Bit Rate
CCS	Common Channel Signalling
CD	Campus Distributor
CDMA	Code Division Multiple Access
CDMA-DS	Code Division Multiple Access – Direct Sequence
CDV	Cell Delay Variation
CGI	Common Gateway Interface
CIDR	Classless Inter-Domain Routing
CLI	Call Line Identifiers
CLR	Cell Loss Rate
CN	Core Network
CPS	Call Processing Subsystem
CPU	Central Processing Unit
CRC	Cyclic Redundancy Check
CS	Circuit Switched
CSMA/CD	Carrier Sensing Multiple Access/Collision Detection
CTD	Cell Transfer Delay
CW	Continous Wave
DA	Destination Address

dB	decibel
d.c.	direct current
DCE	Data Circuit-terminal Equipment
DHCP	Dynamic Host Configuration Protocol
DLT	Digital Line Termination
DM	Delta Modulation
DNS	Domain Name Service
DOD	Department Of Defence
DPSK	Differential Phase Shift Keying
DSB	Double-SideBand
DSS	Digital Switching Subsystem
DSSS	Digital Subscriber Switching Subsystem
DTE	Data Terminal Equipment
DWDM	Dense Wavelength Division Multiplexing
Eb/No	Energy of Bit-to-Noise Density Ratio
EDGE	Enhanced Data rates for GSM Evolution
EDH	European Digital Hierarchy
EGP	Exterior Gateway Protocol
e.h.f.	extra high frequency
EIR	Equipment Identity Register
EIRP	Effective Isotropic Radiated Power
ELFEXT	Equal Level Far End CrossTalk
EMI	Electro Magnetic Interface OR Electro Magnetic Interference
EPOS	Electronic Point Of Sale
ES	End Systems
ETSI	European Telecommunications Standards Institute
F	noise Factor
FCS	Frame Check Sequence
FD	Floor Distributor
FDD	Fequency Division Duplex
FDDI	Fibre Distributed Data Interface
FEC	Forward Error Control
FET	Field Effect Transistors
FEXT	Far End Crosstalk
FM	Frequency Modulation
FSK	Frequency-Shift Keying
ftp	file transfer protocol
GFI	General Format Indicator
GPR	General Packet Radio
GPS	Global Positioning Satellites
GSM	Global System for Mobile telecommunications
GTP	GPRR Tunnelling Protocol
GUI	Graphical User Interface
HDLC	High-level Data Link Control
h.f.	high frequency
HLR	Home Location Register
HTML	Hyper Text Markup Language
http	hyper text transfer protocol
HVAC	Heat Ventilation Air-Conditioning
ICMP	Internet Control Message Protocol
ICT	Information and Communication Technology
IDC	Internet Data Centre
IEC	International Electrotechnical Comission
IEEE	Institute of Electrical & Electronic Engineering
IETF	Internet Engineering Task Force

i.f.	intermediate frequency
IGP	Interior Gateway Protocol
IMT-2000	International Mobile Telecommunications – 2000
IN	Intelligent Networks
IP	Internet Protocol
IPsec	Internet Protocol security
IPv6	Internet Protocol version 6
IPX	Internet Packet eXchange
IS	Intermediate System
ISDN	Integrated Services Digital Network
ISI	Inter Symbol Interference
IS-IS	Intermediate-System to Intermediate-System
ISO	International Standards Organisation
ISP	Internet Service Provider
ITU	International Telecommunications Union
JVM	Java Virtual Machine
LAN	Local Area Network
LAP	Link Access Protocol
LAPB	Link Access Procedure Balanced
LAPD	Link Access Procedure on the D channel
LAPF	Link Access Procedure for Frame relay
LAPM	Link Access Procedure for Modems
LCGN	Logical Channel Group Number
LCN	Logical Channel Number
LDN	Local Distribution Network
LED	Light Emitting Diodes
l.f.	low frequency
LLC	Logical Link Control
LNP	Local Number Portability
LSA	Link State Advertisement
MAC	Medium Access Control
MAN	Metropolitan Area Network
MCS	Maintenance Control Subsystem
MDF	Main Distribution Frame
m.f.	medium frequency
MIB	Management Information Base
MMIS	Man Machine Interface Subsystem
MS	Mobile Station
MSC	Mobile Switching Centre
MSS	Management Statistics Subsystem
mtbf	mean-time-between-failures
MTP	Message Transfer Part
MTS	Message Transmission Subsystem
mttr	mean time to repair
NA	Numerical Aperture
NADH	North American Digital Hierarchy
NAT	Network Address Translation
NEXT	Near End CrossTalk
NF	Noise Factor
NIC	Network Interface Card
NMS	Network Management System
NSS	Network Synchronisation Subsystem
NUA	Network User Address
OOP	Object Oriented Programming
op-amp	operational amplifiers

OSI	Open Systems Interconnection
OSIRM	Open Systems Interconnection Reference Model
OSPF	Open Shortest Path First
OVSF	Orthogonal Variable Spreading Factor
PABX	Private Automatic Branch Exchanges
PAD	Packet Assembler / Dissembler
PAM	Pulse Amplitude Modulation
PAMR	Public Access Mobile Radio
PBX	Private Branch eXchange
PC	Personal Computer
PCM	Pulse Code Modulation
PCR	Peak Cell Rate
PDCP	Packet Data Convergence Protocol
PDH	Plesiochronous Digital Hierarchy
PDN	Public Data Network
PHP	Perl Hypertext Pre-Processor
PIN	P-type Intrinsic N-type
PKI	Public Key Infrastructure
PLM	Public Land Mobile Landwork
PM	Phase Modulation
PMR	Private Mobile Radio
POTS	Plain Old Telephone System
PPM	Pulse Position Modulation
PPP	Point-to-Point-Protocol
pps	packets per second
PS	Packet Switched
PSNEXT	Power Sun NEXT
PSK	Phase-Shift Keying
PSTN	Public Switched Telecommunications Network
PTI	Packet Type Identifier
PTO	Public Telecommunications Operators
PUS	Processor Utility Subsystem
PVC	Permanent Virtual Circuit
PWM	Pulse Width Modulation
QAM	Quadrature-Amplitude Modulation
QoS	Quality of Service
QPSK	Quadrature Phase Shift Keying
R99	Release 99
RAID	Redundant Array of Independent Drives
RAKE	Radio Activated Key Entry
RAM	Random Access Memory
r.f.	radio frequency
RFC	Request For Comments
RFP	Request For Proposal
RIP	Routing Information Protocol
RLC	Radio Link Control
RMON	Remote Monitoring
r.m.s.	root mean square
ROADS	Running Out Of ADdress Space
RTO	Regional Telephone Operators
SA	Source Address
SAP	Service Advertisement Protocol
SCCP	Signalling Connection Control Part
SCP	Service Control Point
SCR	Sustained Cell Rate

SDH	Synchronous Digital Hierarchy
SFD	Start Frame Delimiter
SGML	Standard Generalized Markup Language
s.h.f.	super high frequency
SLA	Service Level Agreement OR Synchronous Line Adapter
SLD	Semiconductor Laser Diodes
SMI	Structure of Management Information
smtp	simple mail transfer protocol
SNMP	Simple Network Management Protocol
SONET	Synchronous Optical NETwork
SPC	Stored Program Control
SQL	Standard Query Language
SS7	Signalling System No. 7
SSB	Single-SideBand
SSM	Solstice Sunnet Manager
SSP	Service Switching Point
SSW	Space SWitch
STA	Spanning Tree Algorithm
STM	Synchronous Transfer Mode
STP	Shielded Twisted Pair OR Signal Transfer Point OR Spanning Tree Protocol
STS	Synchronous Transfer Signal
SVC	Switched Virtual Circuit
TCAP	Transaction Capabilities Application Part
TCP	Transmission Control Protocol
TCP/IP	Transmission Control Protocol/Internet Protocol
TDM	Time Division Multiplexing
TDMA	Time Division Multiple Access
TETRA	Terrestrial Trunked Radio
TFTP	Trivial File Transfer Protocol
TNS	Test Network Subsystem
TO	Telecommunication Outlet
TP	Transition Point
TRF	Tuned Radio Frequency
TSW	Time SWitch
TTL	Time To Live
TUP	Telephone User Part
UBR	Unspecified Bit Rate
UDP	User Datagram Protocol
u.h.f.	ultra high frequency
UML	Unified Modelling Language
UMTS	Universal Mobile Telephone System
UPS	Uninterrupted Power Supply
UTP	Unshielded Twisted Pair
UTRAN	UMTS Terrestrial Radio Access Network
VBR	Variable Bit Rate
VCC	Virtual Channel Connection
VCI	Virtual Channel Identifier
v.h.f.	very high frequency
VLAN	Virtual Local Area Network
v.l.f.	very low frequency
VLR	Visitor Location Register
VLSM	Variable Length Subnet Masks
VOIP	Voice Over Internet Protocol
VPC	Virtual Path Connection
VPI	Virtual Path Identifier

VPN	Virtual Private Network
VSAT	Very Small Aperture Satellite
WAN	Wide Area Network
WDM	Wavelength Division Multiplexing
xDSL	xDigital Subscriber Line
XML	eXtensible Markup Language
XOS	Cross Office Slot

Appendix B

Resource requirements

City & Guilds has identified a list of minimum requirements for the Advanced Technician Diploma in Telecommunication Systems. You should use this list to make sure that you have the necessary resources to offer the programme.

The visiting verifier should also use this list to check that all candidates have access to the resources needed to be successful. You do not have to provide all the resources in one location, for example you may have teaching rooms in one location and you may use a different location (such as a workshop and laboratories) to provide access to resources that are not in the teaching rooms.

This list is intended to be appropriate to a wide range of locations. For example, electronic component catalogues may come from Internet sources that originate from the local or worldwide market.

Advanced Diploma – resource list

Accommodation

- Teaching rooms, workshops and laboratories.
- Layout of premises to allow for good work flow.

Equipment and tools

- Scientific calculators
- Personal computers
- Ethernet network cards
- Ethernet hub or switch
- Category 5 cables with RJ45 connectors
- Printers
- Storage media
- Software applications
    - *Software:* word processing, database, spreadsheet, packet analyser/sniffer
    - Maps and local guide books
- Electronic components
    - *Components:,* resistors, capacitors, inductors, transformers, electromagnetic relays, semiconductor diodes, transistors (bipolar and field-effect), integrated circuits (linear), logic gates (AND, OR, NAND, NOR, Exclusive OR), connectors
- Test equipment
    - *Equipment:* power supplies, ammeters, voltmeters, oscilloscopes, continuity testers, protocol analyser, network analyser, network simulator, optical power meters telephone instruments, modems, radio receivers (multiband), loudspeakers, microphones, television receivers,
- Communications media
    - *Media:* twin, multi-core/ multi-pair, ribbon cable, twisted pair (shielded and unshielded), coaxial cables, waveguide, optical fibres (mono-mode, multi-mode, graded-index); examples of structured cabling
- Electronic component catalogues
    - *Catalogues:* eg Farnell Electronic Components (http://www.farnell.com/), RS Components (www1.rswww.com), Combined Precision Components (http://www.cpc.co.uk/), Maplin electronics (www.maplin.co.uk)
    - Electronic component catalogues from (local) national or other international suppliers may be considered equivalent.
- Network component catalogues
    - *Catalogues:* eg Misco Networking (http://www.misco.co.uk), Cisco (http://www.cisco.com), Extreme Networks (http://www.extremenetworks.com)
    - Network component catalogues from (local) national or other international suppliers.

- Network reference sites:
  http://www.iec.org/online/tutorials/, http://www.ietf.org/rfc.html, http://www.iso.org,
  http://standards.ieee.org/
- Reference books: See recommended reading list.

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Appendix C

Practical Assignments

Two assessment methods are used in the 2730 Technician Awards in Telecommunication Systems programme – written questions and practical assignments.

Practical assignments

Each unit or component in the advanced diploma level of this programme has one related practical assignment. These assignments may call on skills covered in other sections but reference is only made to the objectives covered by the marking criteria. Wherever relevant, the option is given to you to use local names, local standards, alternative measures and paper sizes, or to design an alternative assignment. Where this option is taken **the assignment must be of a comparable standard** to ensure consistency between centres using this programme. The assignment must be documented and available to the visiting verifier. ALL assignments must be successfully completed.

The assignments may be administered at any time convenient to the instructor and to the candidate.

The practical assignments in this publication are intended to be photocopied.

Instructor notes

It is essential that you read these before attempting to administer the practical assignment. Practical assignments usually require you to prepare material for the assignment.

Candidate instructions

Make sure every candidate has a copy of these before beginning the practical assignment.

Marking

The marking is based on performance criteria or outcomes related to the practical assignment, to which the answer will always be either 'yes' – the candidate achieved this or 'no' – the candidate did not achieve this. Credit is given for those performance objectives for which the answer is 'yes' – the candidate achieved this.

Supervision

All assignments require supervision and you must make sure that the results reflect only the individual candidate's own work. You must keep all assessment documentation and material in a file for each candidate until the results have been agreed by the visiting verifier and until confirmation of the result has been received from City & Guilds.

Records, results and certification

Successful completion of the related practical assignments for each unit or component needs to be recorded and then sent to City & Guilds. We suggest that you keep a record of each individual's achievement that may then be transferred to the entry forms. A model is given at the end of this section but you may use any form of record keeping that is convenient and accessible.

In order to gain certification, results for successfully completed practical assignments must be sent to City & Guilds. Results for practical assignments are entered onto *Form S* that must be countersigned by the visiting verifier and sent to us. A sample *Form S* is included in appendix D.

An advantage of this programme is that candidates who successfully complete the practical assignments

for a single unit or component may, if they wish, claim a certificate of unit credit. This may be beneficial for those candidates who only wish to complete part of this programme. Send these claims to us at any time provided the visiting verifier has countersigned the *Form S*.

Candidates wishing to gain the full award (certificate, diploma or advanced diploma) must successfully complete all forms of assessment. We recommend that the practical results are sent at the time of, or shortly before, the date of the written examinations.

Visiting verifier

The operation of this programme requires the appointment of a visiting verifier. **The visiting verifier must countersign the results of the practical assignments on *Form S***. The visiting verifier should also be able to inspect records and candidates' work to verify the results before submission. A full description of the role of the visiting verifier is in appendix D.

Advanced Technician Diploma in Telecommunication Systems **Candidate assessment record**	*Candidates must complete this assignment
Candidate's name and number	
Centre name and number	

Assessment reference	**Date completed**	**Instructor signature**	**Instructor name**
021/1 Telecommunications Project *			
024/1 Advanced Radio Systems Practice			
026/1 Software Engineering Practice			

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Appendix D

City & Guilds Approval and Administration Procedures

We have an administration system for working with organisations internationally. This system is designed to assure the integrity of the assessment process, make communication easier, and ensure that our records are accurate. If you wish to use City & Guilds assessments you must do two things – apply for approval to offer a specific assessment programme and apply for approval to become an examination centre.

As a centre approved to offer a specific assessment programme such as the Technician Awards in Telecommunication Systems you are agreeing to organise courses of instruction in preparation for examinations in this subject.

As an approved examination centre, you will be responsible for registering individual candidates for each part of the assessment programme, including external candidates if they apply to your centre, conducting assessments, reporting results to us, and presenting our certificates and certificates of unit credit to successful candidates. A certificate of unit credit shows partial completion of the requirements for a full certificate or diploma as described in this syllabus.

City & Guilds reserves the right to suspend an approved centre, or withdraw its approval from an approved centre or for an approved centre to conduct a particular City & Guilds scheme or particular City & Guilds schemes, for reason of debt, malpractice or for any reason that may be detrimental to the maintenance of authentic, reliable and valid qualifications or that may prejudice the name of City & Guilds.

The next section shows the specific procedures you must follow to get approval, register candidates, and send results. Copies of all necessary forms are included in this appendix, with notes added where we think these may be helpful. The copies show sample candidate entry forms for 2730 Advanced Technician Diploma in Telecommunication Systems.

For this programme your attention is drawn to the following:

1 For assessment of practical work send us the form for the visiting verifier, *Form INT/APP 2*. If we accept your nomination we will write and tell you that the nomination has been accepted, and that you may accept candidates for the practical part of the assessment.

2 Send the *Dated Entry and Results Submission (Form S)* in time to reach us by the time stated in the *International Directory of Examinations and Assessments* for examinations in this subject. *A separate Form S must be used for each complex level; ie entries for 2730-**02**-011 must be on a separate sheet from entries for 2730-**03**-021. Form S* and other forms require the use of subject and other numbers that are part of our internal administrative procedure.

For the *Technician Awards in Telecommunication Systems* the numbers are as follows:

The subject number is 2730

The award number is 2730-03 for entries for the advanced diploma level.

The component numbers are the numbers used to identify each unit in this programme. These are listed on page 8. Subject, complex and component numbers are also used in the syllabus for each unit.

These numbers may have to be changed from time to time, in which case we will let you know about the changes.

After receiving the completed Form S we will send you a list of registered candidates to check that the details are correct. Before the actual examination date, we will send the required number of written tests and multiple-choice answer sheets *(Form MA)* and any other materials you need for the examinations.

NOTE. If you represent a school, college or other organisation making entries through a separate examination centre, such as a branch office of a local education department, you must make sure that sufficient time is allowed to complete these procedures.

Examination materials are returned to us immediately after the examination, using the fastest possible route. This avoids delay in processing results.

3 Your results for practical assessments are sent to us with the completed *Results Submission (Form S)*. Prompt return of *Form S* avoids delay in processing results.

We will send details of candidates' examination results to the examination centre and certificates of unit credit and/or certificates, diplomas and advanced diplomas for successful candidates.

4 We also give guidance on these procedures in the current edition of the *International Directory of Examinations and Assessments* which is automatically distributed to registered examination centres.

City & Guilds International

Guidance INT/APP 1

Guide to getting approval guidance notes

Introduction

Centre approval is available to any college, company or training centre. You must apply to become a City & Guilds International Approved Centre if you wish to offer our programmes.

Programme approval is required if you wish to operate a programme, and examination centre approval is required in order to submit candidate entries and carry out examinations.

- Programme approval – complete Section 2 of the Application Form (INT/APP1).
- Examination centre approval – complete Section 3 of the Application Form (INT/APP1).
- Programme and examination centre approval – complete all of the Application Form (INT/APP1).

Procedures

1 Please choose the programme(s) that you wish to offer. A full list appears in the International Handbook. Before completing the form you must **read the relevant syllabus and regulations**. These publications are available from our Branch Offices or from head office. You will find an order form for publications in the International publications list. Additional requirements for the programme are detailed in the International Handbook.

Please Note: 'Syllabus and Regulations' is the new term for 'Scheme Pamphlet'.

2 The relevant forms should be completed and returned to either City & Guilds Customer Services International or the appropriate Branch Office in your area.

3 A separate form must be completed for each programme application. The request for examination centre approval need only be made once.

Please Note: If you intend to make a number of applications, please photocopy the application form.

4 **Programme Application**

You will receive formal notification from City & Guilds International including:

- an invoice for the approval fee(s)
- programme approval centre document(s)
- a presentation pack of International publications
- an International Directory of Examinations and Assessments
- Form S – registration, dated entry and results submission

Please Note: Approval for most of our programmes requires the appointment of a suitably qualified and experienced Visiting Verifier. Please refer to the International Handbook for details. You are required to make nominations for the role of your Visiting Verifier (see Form INT/APP2) **at the time of application for approval to offer the programme**. Appointments are made by City & Guilds International after considering the suitability of the nominees. Nominees should be suitably qualified and experienced but **NOT an employee from your centre**. People from industry or the public services and who are in a supervisory or management role would be appropriate. You and your nominee must read the criteria for appointment and the role and duties of a Visiting Verifier on page 7.

5 **Examination Centre Approval**

You will receive formal notification from City & Guilds International when your application is successful. A centre number will be allocated. No entries may be made until you are given this number.

You will receive:

- an invoice for the required fees.
- an examination centre approval document.
- an International Directory of Examinations and Assessments.
- examination entry forms.

Please Note: Centres in some countries are required to enter all candidates for City & Guilds International examinations through their local government education department who will be an approved examinations centre.

City & Guilds International

INT/APP 1

Application form for approval to offer a City & Guilds international programme and/or examinations

Programme number:	2730	Level: Cert/Dip/Adv Dip
Programme title:	Telecommunication Systems	
Section 1 **Centre details:**		
Name of centre:		
City & Guilds centre number (if known):		
Address for **all** correspondence (ie. Postal): Post Code: Country:		
Location address (if different from above): Country:		
Telephone number:		
Fax number:	e mail:	
Signature of head of section/department/faculty/principal:		
Name: Position:		Date:

Section 2		INT/APP 1
Programme approval statements of competence:		
Please read the following statements carefully then tick all the boxes that apply to the programme for which approval is requested.		
a)	**I have read the Syllabus and Regulations and assure City & Guilds International that the syllabus and assessments are appropriate for the candidates and that the teaching will be undertaken by suitably qualified and experienced staff.**	
b)	**The centre has the practical equipment necessary for the delivery and assessment of this programme.**	
	*** City & Guilds International reserves the right to request details of staffing and equipment. (See Forms INT/APP3 and INT/APP4 on pages 13 and 14).**	
c)	The teaching staff understand the concept of coursework and practical assessment and assure City & Guilds International that all practical assessments will be undertaken at appropriate times under examination conditions and, where applicable, supervised by senior staff members.	
d)	I enclose a completed notification form for the Visiting Verifier (if required for this subject) and both the Visiting Verifier and myself understand the responsibilities. (Please refer to the International Handbook for details).	
e)	I hereby accept and agree to abide by the rules and regulations of City & Guilds International as set out in the Directory of Examinations and Assessments.	

Name:	Position:
Signature of head of section/department/ faculty/principal:	Date:
Name:	Position:
Signature of local examination secretary:	Date:

Section 3	INT/APP 1
Examination centre approval statements of competence:	
This section need only be completed by applicants who do not already have a City & Guilds examination centre number:	
a) I certify that the centre has the necessary facilities for written examinations. All question papers will be held unopened in a secure place until the time of the examination. All examinations will be invigilated according to the rules and regulations of City & Guilds International as set out in the International Directory of Examinations and Assessments. I also understand that a representative of City & Guilds International has the right to visit the centre during tuition, training and examination times. Submissions/entries for coursework/practicals can only be made if the centre also holds necessary programme approval (see Section 2, Page 4).	
b) I attach a reference from the centre's bank for credit and exchange purposes.	
Name:	Position:
Signature of principal/managing director/ government authority:	Date:

Section 4	INT/APP 1
Approval fees:	
a) I understand that my organisation will be invoiced for centre approval fees and I hereby agree to pay promptly. I understand that failure to do so may result in suspension of approval.	
Name:	Position:
Signature of principal/managing director/ government authority:	Date:

When completed please return to City & Guilds Customer Services International, or the appropriate Branch Office.

For office use only:		
Date received:	Date forwarded (as appropriate):	Date logged:

Action Taken:	
Additional information:	Date requested:
Check centre records:	Date:
Armchair assessor:	Date sent:
Approved:	Date:
Copy to Head Office/Officer/Branch Office:	Date:

Criteria for the nomination of Visiting Verifier

Professional

1 Understanding of the nature of the programme and the type of student group.

2 Knowledge of the content of the programme and assessments required.

3 Evidence of experience in the subject field, either through employment or through responsibility for placement supervision over a period of time.

4 Knowledge and understanding of City & Guilds International provision of programmes in the subject field.

Personal

1 Good communication and inter-personal skills.

2 Willingness to support and advise the course team.

3 Willingness and ability to write reports which provide objective recommendations that will enable City & Guilds International to identify strengths/weaknesses of the work being done – thus maintaining the required standards.

4 Commitment to maintaining the quality of practical assessments.

5 Ability to work with the centre in a fair and impartial manner.

Commitment Required

1 Accept responsibility for a centre for a minimum of 2 years.

2 Carry out Visiting Verifier responsibilities as agreed with the centre and City & Guilds International. (As detailed below)

3 Support to centre by telephone/correspondence/visits.

4 Familiarisation with City & Guilds International aims and philosophy as detailed in City & Guilds documentation.

The role and duties of the Visiting Verifier

It is City & Guilds International policy to ensure the reliability, credibility and validity of our awards. We do this by appointing Visiting Verifiers to monitor the standards of assessments being carried out by staff in approved centres.

The centre is responsible for the assessment of the candidates' practical ability. The Visiting Verifier is responsible for verifying that the assessments carried out by the centre and the results obtained are in accordance with the required standards.

It is essential for the success of the programme that the centre and Visiting Verifier develop a good working relationship through regular and open communication.

It is the responsibility of the centre to nominate a potential Visiting Verifier. Please ensure that the completed application form is sent with the centre approval form. **The Visiting Verifier must not be employed by the centre**.

The Visiting Verifier will be paid a fee by City & Guilds International.

City & Guilds International is not responsible for paying the Visiting Verifier's travel expenses. These must be paid by the centre.

The course may start once approval has been granted. The Visiting Verifier will be informed of the approval by City & Guilds International, we will request that he/she contact you to discuss a visit and their role and duties.

The main duties of the Visiting Verifier are to monitor, evaluate and approve the assessments by means of a visit arranged on a mutually convenient date to ensure that:

- proper procedures have been followed
- practical and written assessments have been correctly administered
- all the candidates who have met the required standard are recorded as successful
- only the candidates who have met the required standard are recorded as successful.

In order to do this the Visiting Verifier will need to:

- meet staff responsible for practical and written assessments and maintaining assessment records
- examine the centre's assessment records
- observe practical assessments taking place
- refer to centre approval documentation
- have access to tutors' and work placement supervisors' notes and schedules.

The Visiting Verifier will contact the centre as soon as possible after the programme has started to verify that the assessment procedures are fully understood. Occasionally a visit may be required at this stage to solve problems. At least one visit will be made annually, usually towards the end of the course.

It is not possible for the Visiting Verifier to monitor every assessment that takes place. A sample of 5 - 8% should be sufficient to establish the existence of satisfactory procedures.

The Visiting Verifier may request that a particular group of candidates be present during his/her visit but should be prepared to be flexible. It is not the individual candidate who is being assessed but the centre's ability to assess to the specified standards. Verification of these standards may be carried out on any candidate.

Candidates should not be expected to attempt formal assessment until they are ready.

When candidates have been successful in the assessed components the ICMs (Invigilation Certificates/Marksheets) or Form S – whichever is being used – can be submitted to City & Guilds for Certification. If the Visiting Verifier has not made his/her annual visit by this stage, he/she must be consulted before the submission. This is in order to check that assessment procedures were satisfactory and any problems arising during the course have been resolved. At this stage the Visiting Verifier can complete and submit the Visiting Verifier Report Form and countersign the ICM/Form S.

Visiting Verifiers are required to satisfy themselves that the resources at each centre enable candidates to experience all aspects of the syllabus. Where such provision falls short of the specified standards and where candidates' work is clearly below the required standard, recommendations for improvement will be made and reported to City & Guilds International.

City & Guilds International

INT/APP 2

Application for the post of visiting verifier

Please complete in **block capitals** or typescript.		
Name of centre:	Centre no: (if known)	
Application for the post of visiting verifier for (programme title & number): 2730 Telecommunication Systems		
Section 1 **Personal details:**		
Surname: First name:	Mr/Mrs/Miss/Ms:	
Date of birth: (Day/Month/Year)		
Home postal address:		
Home telephone number:		
Business postal address:		
Business telephone number:		
Business fax number:	Business e mail:	
Please ✓ address to be used for correspondence:	Home:	Business:
Please ✓ telephone number to be used:	Home:	Business:

Section 2		INT/APP 2
Employment history:		
Present/most recent employment:		
Please give details as follows:		
Work experience: (most recent first, including part-time)		
Employer:	Position held:	Dates: (from – to)
Teacher/trainer experience: (most recent first, including part time)		
Employer:	Position held:	Dates: (from – to)
Examining/verifying experience: (most recent first)		
Employer:	Position held:	Dates: (from – to)

Section 3 INT/APP 2 **Educational history:**		
Please give details of relevant qualifications and courses attended:		
Subject:	Qualification/ centre:	Date of award/ course:

Section 4 **Experience of subject:**		
Please ✓ as appropriate:		
Are you currently involved in teaching/training of the programme:	Yes:	No:
For how long?	1 – 2 years:	3+ years:
In what capacity?		

Section 5 **Other involvements with City & Guilds:**		
List any other work which you undertake on behalf of City & Guilds:		
Programme/subject:	Role: (Committees/ Examiner/Verifier etc.)	Dates: (from – to)

Section 6 INT/APP 2 **Referee:**	
Please provide the names and addresses of two persons of standing in the local community whom we may invite to testify to the quality of your experience in the education and training field.	
Name:	
Business address:	
Business telephone no:	
Signature: Date:	

Name:	
Business address:	
Business telephone no:	
Signature: Date:	

Equipment details		INT/APP 3
Please provide details of equipment relevant to the programme for which approval is being requested:		
Item No	Description	Qty
Note: Copies of inventories may be attached.		

Staffing details		INT/APP 4
Please provide details and experience of teaching staff (relevant to your programme approval application)		
Name	Qualifications	Experience
Note: Prospectus or CV's may be submitted if correct and accurate.		

Form S

Form S has been designed to make your job easier by replacing forms BC, D, and M. You can start using Form S immediately.

The following pages show examples of Form S completed for 2730 *Telecommunication Systems* at advanced diploma level. The first example shows Form S completed for making entries for the written paper. The second example shows Form S completed for making entries for the practical assessment at advanced diploma level.

There is also a blank copy of Form S with the guidance notes for its completion, which you can photocopy and use for your own purposes. Some of the guidance notes are specific to centres in the UK. Therefore please note the following additional information for centres outside the UK.

Ethnic background

You are not required to complete this section.

(L)TEC Code

You are not required to complete this section.

Counter signature

Form S MUST be countersigned by the visiting verifier when you use Form S to send us results of practical assessments.

If you have any questions about how to fill in Form S you should contact:

International Operations Department
City & Guilds International
1 Giltspur Street
London EC1A 9DD

Tel: +44 (0) 20 7294 2885
Fax: +44 (0) 20 7294 2403
E-mail: international@city-and-guilds.co.uk

This form will be scanned. Please use BLOCK CAPITALS.
Do not staple, clip, fold or fax this form.
Please send this form to: City & Guilds, Data Processing, 1 Giltspur Street, London EC1A 9DD.
If you have any questions about how to fill in this form, please phone Entries and Results Customer Support on 020 7294 2787.
Please read the guidance notes over the page before you fill in this form.

City & Guilds

Form S – registration, dated entry and results submission

Registration	TICK
Dated entry for	MONTH OF TEST: JUN (SEE CODE OVERLEAF)
Results submission	TICK

Centre number	Sub	Name
899999		PRETORIA TECHNICAL INSTITUTE

Award number	Award title	Syllabus code
273003	ADVANCED TECHNICIAN DIPLOMA IN TELECOMMUNICATION SYSTEMS	

Centre contact	Phone number	Purchase order number or customer reference
IAN NOLAN	875 3217 4492	

Insert enrolment number if known (use BLOCK CAPITALS)	The candidate's name is not necessary when you have given the enrolment number. (Please use BLOCK CAPITALS.)	Sex	Date of birth	Ethnic background	Particular requirements	(L)TEC code	Duplicate to above	Continue on next line
ENR	SUSAN BAILEY	F	260362	CODE OVERLEAF			✓	✓
COMP NO. / GRADE: 022, 023								
ENR	GEORGE UMTALI	M	110780	CODE OVERLEAF			✓	✓
COMP NO. / GRADE: 022, 025								
ENR	SAMUEL SIBLEY	M	131279	CODE OVERLEAF			✓	✓
COMP NO. / GRADE								
ENR	VICTORIA BROWN	F	050582	CODE OVERLEAF			✓	✓
COMP NO. / GRADE								
ENR	CANDIDATE NAME	M/F	DDMMYY	CODE OVERLEAF			✓	✓
COMP NO. / GRADE								
ENR	CANDIDATE NAME	M/F	DDMMYY	CODE OVERLEAF			✓	✓
COMP NO. / GRADE								
ENR	CANDIDATE NAME	M/F	DDMMYY	CODE OVERLEAF			✓	✓
COMP NO. / GRADE								
ENR	CANDIDATE NAME	M/F	DDMMYY	CODE OVERLEAF			✓	✓
COMP NO. / GRADE								
ENR	CANDIDATE NAME	M/F	DDMMYY	CODE OVERLEAF			✓	✓
COMP NO. / GRADE								
ENR	CANDIDATE NAME	M/F	DDMMYY	CODE OVERLEAF			✓	✓
COMP NO. / GRADE								

FR-00-3209

I confirm that the candidates above are entered in line with City & Guilds regulations.

Your signature: Jan Jones Page 1 of 1 Date: 16/ 7 / 02 Counter signature (if needed) ....

Send the top copy to City & Guilds. Keep the second copy for your own records.

City & Guilds

Form S – registration, dated entry and results submission

This form will be scanned. Please use BLOCK CAPITALS.
Do not staple, clip, fold or fax this form.
Please send this form to: City & Guilds, Data Processing, 1 Giltspur Street, London EC1A 9DD.
If you have any questions about how to fill in this form, please phone Entries and Results Customer Support on 020 7294 2787.
Please read the guidance notes over the page before you fill in this form.

Registration	TICK
Dated entry for	MONTH OF TEST: SEE CODE OVERLEAF
Results submission	TICK ✓

Centre number	Sub	Name	
899999		PRETORIA TECHNICAL INSTITUTE	
Award number	**Award title**		**Syllabus code**
273003	ADVANCED TECHNICIAN DIPLOMA IN TELECOMMUNICATION SYSTEMS		
Centre contact	**Phone number**	**Purchase order number or customer reference**	
IAN NOLAN	875 3217 4492		

Insert enrolment number if known (use BLOCK CAPITALS)	The candidate's name is not necessary when you have given the enrolment number. (Please use BLOCK CAPITALS.)	Sex	Date of birth	Ethnic background	Particular requirements	(L)TEC code	Duplicate to above	Continue on next line
ABC1234	SUSAN BAILEY	F	260362	CODE OVERLEAF			✓	✓
021P 024P	COMP NO. GRADE (×14)							
DEF6789	SAMUEL SIBLEY	M	131279	CODE OVERLEAF			✓	✓
021P 026P	COMP NO. GRADE (×14)							
ENR	CANDIDATE NAME	M/F	DDMMYY	CODE OVERLEAF			✓	✓
COMP NO. GRADE (×15)								
ENR	CANDIDATE NAME	M/F	DDMMYY	CODE OVERLEAF			✓	✓
COMP NO. GRADE (×15)								
ENR	CANDIDATE NAME	M/F	DDMMYY	CODE OVERLEAF			✓	✓
COMP NO. GRADE (×15)								
ENR	CANDIDATE NAME	M/F	DDMMYY	CODE OVERLEAF			✓	✓
COMP NO. GRADE (×15)								
ENR	CANDIDATE NAME	M/F	DDMMYY	CODE OVERLEAF			✓	✓
COMP NO. GRADE (×15)								
ENR	CANDIDATE NAME	M/F	DDMMYY	CODE OVERLEAF			✓	✓
COMP NO. GRADE (×15)								
ENR	CANDIDATE NAME	M/F	DDMMYY	CODE OVERLEAF			✓	✓
COMP NO. GRADE (×15)								
ENR	CANDIDATE NAME	M/F	DDMMYY	CODE OVERLEAF			✓	✓
COMP NO. GRADE (×15)								

FR-00-3209

I confirm that the candidates above are entered in line with City & Guilds regulations.

Your signature: *Ian Jones* Page 1 of 1 Date: 27/05/02 Counter signature (if needed) *L. J. Abbott*

Send the top copy to City & Guilds. Keep the second copy for your own records.

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City & Guilds

Form S – registration, dated entry and results submission

This form will be scanned. Please use BLOCK CAPITALS.
Do not staple, clip, fold or fax this form.
Please send this form to: City & Guilds, Data Processing, 1 Giltspur Street, London EC1A 9DD.
If you have any questions about how to fill in this form, please phone Entries and Results Customer Support on 020 7294 2787.
Please read the guidance notes over the page before you fill in this form.

Registration	TICK
Dated entry for	MONTH OF TEST / SEE CODE OVERLEAF
Results submission	TICK

Centre number	Sub	Name	
Award number	Award title		Syllabus code
Centre contact	Phone number	Purchase order number or customer reference	

Insert enrolment number if known (use BLOCK CAPITALS)	The candidate's name is not necessary when you have given the enrolment number. (Please use BLOCK CAPITALS.)	Sex	Date of birth	Ethnic background	Particular requirements	(L)TEC code	Duplicate to above	Continue on next line
E N R	C A N D I D A T E N A M E	M/F	D D M M Y Y	CODE OVERLEAF			✓	✓
COMP NO. GRADE COMP NO. GRADE COMP NO. GRADE COMP NO. GRADE COMP NO. GRADE COMP NO. GRADE COMP NO. GRADE COMP NO. GRADE COMP NO. GRADE COMP NO. GRADE COMP NO. GRADE COMP NO. GRADE COMP NO. GRADE COMP NO. GRADE COMP NO. GRADE								
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COMP NO. GRADE COMP NO. GRADE COMP NO. GRADE COMP NO. GRADE COMP NO. GRADE COMP NO. GRADE COMP NO. GRADE COMP NO. GRADE COMP NO. GRADE COMP NO. GRADE COMP NO. GRADE COMP NO. GRADE COMP NO. GRADE COMP NO. GRADE COMP NO. GRADE								
E N R	C A N D I D A T E N A M E	M/F	D D M M Y Y	CODE OVERLEAF			✓	✓
COMP NO. GRADE COMP NO. GRADE COMP NO. GRADE COMP NO. GRADE COMP NO. GRADE COMP NO. GRADE COMP NO. GRADE COMP NO. GRADE COMP NO. GRADE COMP NO. GRADE COMP NO. GRADE COMP NO. GRADE COMP NO. GRADE COMP NO. GRADE COMP NO. GRADE								
E N R	C A N D I D A T E N A M E	M/F	D D M M Y Y	CODE OVERLEAF			✓	✓
COMP NO. GRADE COMP NO. GRADE COMP NO. GRADE COMP NO. GRADE COMP NO. GRADE COMP NO. GRADE COMP NO. GRADE COMP NO. GRADE COMP NO. GRADE COMP NO. GRADE COMP NO. GRADE COMP NO. GRADE COMP NO. GRADE COMP NO. GRADE COMP NO. GRADE								

FR-00-3209

I confirm that the candidates above are entered in line with City & Guilds regulations.

Your signature: .... Page ....of................ Date:......./......./....... Counter signature (if needed) ....

Send the top copy to City & Guilds. Keep the second copy for your own records.

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Guidance notes for the registration, dated entry and results submission form

Please refer to the City & Guilds Directory when you fill in this form.

Please fill in this form in black in **BLOCK CAPITALS**. We will only accept the original copy. Please do not send photocopies or faxes. Please do not fold or staple the form.

Important – each form must contain one type of transaction only, either for registration, dated entry or results submission. For example, if you want to make five registrations and five results submissions for the same award number, the registration **must** be listed on a separate form to the results submissions. You can only tick one box on each form.

Registration (old form R) – please tick this box if you are registering candidates, otherwise leave it blank.

Dated entry (old form D) – this refers to examinations that take place on a set date. Please enter the first three letters of the month of the test, for example, JUN = June.

Results submission (old form M) – please tick this box if you are sending us candidates' results for processing and certification, otherwise leave it blank.

Centre number – please enter the six-figure centre number, for example, 023452. Some centres have a single letter, for example, A, which acts as a sub-centre code. Where this applies, please enter this letter in the sub box.

Centre name – please enter the full name of your centre.

Award number – please enter the six-figure award number, for example, 3777-01 (scheme and complex).

Award title – please enter the full title of the award using BLOCK CAPITALS, for example, AIRCRAFT MAINTENANCE ENGINEERING LEVEL 3.

Syllabus code – this applies to dated entry for some centre-devised syllabuses only. Individual centres will have been told about the centre-devised syllabus and the title and code letters which apply. The details of codes are published in our document called 'Centre Devised Syllabus and Question Paper: Notes for Guidance'.

Centre contact – this is usually the name of the Centre Co-ordinator or Examinations Secretary and should be the person signing this form.

Phone number – please include the area code. International centres should also include the country code.

Purchase order number or customer reference – if centres choose to use this section this will be on invoices and nominal roll reports.

Enrolment number – this number has three letters and four digits, for example, DBS2345, and you must quote it if you know it. If the candidate is still waiting for this number, please leave this section blank.

Candidate name – you only need to fill in this section if the candidate is still waiting for their enrolment number. There is space for 30 letters and longer names should be abbreviated. Do **not** include the candidate's title, for example, Mr, Mrs, Dr and so on.

Sex – you must always fill this in. Please say whether the candidate is male (M) or female (F).

Date of birth – this takes the form of DDMMYY, for example, 5 July 1975 will be written as 050775.

Ethnic background – this section is not currently being used.

Particular requirements – codes are available in our document called Access to Assessment for Candidates with Particular Requirements. You can get this, free of charge, from Sales on 020 7294 2850.

LEC and TEC code – although space is available for three numbers, please use the existing two-number code for any TEC or LEC-funded candidates.

Component numbers – some schemes need component numbers to be registered. Please check the directory. For dated entry, please give the components needed. For results submission, please give the components needed and insert a grade.

Duplicate to above – if a few candidates are being submitted for an **identical** set of components, you should give the component set for the first candidate and then you can tick this box for other candidates.

Continue on next line – if a candidate's component entries need more than one line, please tick this section and continue on the next line. You do not need to fill in candidate details again.

Signature/counter signature – the person who signs this should be the contact person at the centre who is referred to in the centre contact section. A counter signature may be necessary for some qualifications or if an internal or external verifier is carrying out a quality assurance check.

Please return this form to Data Processing, City & Guilds, 1 Giltspur Street, London EC1A 9DD.

E-mail: entries@city-and-guilds.co.uk
Website: www.city-and-guilds.co.uk

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Appendix E

The levels of our awards

Progressive structure
Achieving maximum potential

All City & Guilds qualifications are part of an integrated, progressive structure of awards arranged over seven levels, allowing people to progress from foundation to the highest level of professional competence. Senior awards, at levels 4 to 7, recognise outstanding achievement in industry, commerce and the public services. They offer a progressive vocational, rather than academic, route to professional qualifications. An indication of the different levels and their significance is given below.

City & Guilds level	*Qualification/Programme*	
7	**Fellowship (FCGI)**	*the highest level of technological and managerial experience.*
6	**Membership (MCGI)**	*professional or managerial status, at the level of Master's degree.*
5	**Graduateship (GCGI)/Associateship (ACGI)* NVQ5**	*requires the ability to master and apply complex principles and techniques in a variety of contexts and to assume significant responsibility for human and plant resources, at the level of first degree.*
4	**Full Technological Diploma (FTD), Full Technological Certificate (FTC), Advanced Technician Diploma (IVQ), Licentiateship (LCGI), NVQ4**	*demands specialist or technical expertise and the ability to undertake professional work, at the level of Master Craftsman in Europe.*
3	**Technician Diploma (IVQ), Advanced Vocational Diploma (IVQ), Vocational (non NVQ/IVQ) Level 3 NVQ3**	*denotes skilled work of a complex nature and the ability to undertake a supervisory role.*
2	**Technician Certificate (IVQ), Vocational Diploma (IVQ), Vocational (non NVQ/IVQ) Level 2, NVQ2**	*recognises competence in a more demanding range of activities which require a degree of individual responsibility.*
1	**Vocational Certificate (IVQ), Vocational (non NVQ/IVQ) Level 1 Foundation GNVQ NVQ1**	*indicates the ability to perform basic or routine activities which provide the broad foundation for progression.*

* Only graduates of the City & Guilds College, Imperial College of Science, Technology and Medicine, are awarded the Associateship (ACGI).

NVQ – National Vocational Qualifications IVQ – International Vocational Qualifications

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International Vocational Qualifications

IVQs currently available:

- 1100 Skills Certificate in Health and Safety
- 1104 International Certificate in Training Skills
- 1104 International Diploma in Teaching and Training
- 1105 International Assessor Award
- 1121 Retailing
- 1122 Awards in Hairdressing
- 1123 Awards in Beauty Therapy
- 1155 Awards in Engineering Skills
- 2565 Technician Awards in Engineering
- 2730 Technician Awards in Telecommunication Systems
- 3905 Motor Vehicle Engineering
- 4865 International Tourism
- 6161 Construction Industry
- 6165 Construction Industry Technician
- 7065/6/7/8 Hospitality & Catering (Revised Syllabus)
- 7235 Applied Information Technology
- 8030 (2000) Electrical and Electronic Engineering

City & Guilds International 1 Giltspur Street London EC1A 9DD
Telephone +44 (0) 20 7294 3505
Facsimile +44 (0) 20 7294 3506
E-mail: international@city-and-guilds.co.uk
http://www.cityandguilds.com

City & Guilds is a registered charity established to promote education and training

SP-03-2730