The IOA diploma in acoustics and noise control

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The IOA Diploma was started in 1975 to satisfy the educational requirements for Associate membership of the Institute. Since then over 2000 candidates have gained the Diploma and have gone on to become corporate members of the Institute. The Diploma is offered currently at six Higher Education Institutions in the UK and through tutored distance learning supported by extensive course materials. The author has a long experience of teaching the IOA Diploma course, is the current Project Examiner and has contributed to the distance learning notes. The main pedagogical features of the course, particularly of the tutored Distance learning version, which relies on printed teaching materials, supplemented by compulsory laboratory sessions (4 days) and a programme of (optional) tutorials, are described. Statistics will be presented to demonstrate the effectiveness of the course, together with examples taken from course materials, assignments, laboratory exercises, examinations and project investigations.

1 Introduction and History

The 1970s in the UK saw an increase in public concern about noise in the environment and in the workplace. There were very few degree and postgraduate course in acoustics and noise control in UK Universities, and there was growing demand for further education and training in this area. Many higher education colleges and Universities were attempting to meet this demand by providing a range of introductory short courses (typically three afternoons or evenings over about 6 weeks). In 1974 the Control of Pollution Act was issued containing a section on the control of noise pollution in the environment, and the Health and Safety at Work Act produced guidance for controlling the noise exposure of employees in the Workplace, based on the earlier 1972 Department of Employment Code of Practice for reducing the exposure of employed persons to noise.

The introduction of these two pieces of legislation saw a further increase in demand for information and training about noise from those required to deal with them.

The Institute of Acoustics developed the Diploma course in the mid-1970s in response to these developments. The first cohort of students sat their examinations in June 1978.

The curriculum at that time consisted of the study of a compulsory General Principles of Acoustic (GPA) module (60 hours of study) and any two from four specialist modules (30 hours of study for each module): architectural and building acoustics (ABA), noise control engineering (NCE), law and administration (LA), and transportation noise (TN). The award of the Diploma required the achievement of passes in the GPA examination and in two of the four specialist modules, together with the successful completion of a Project, which comprised 60 hours of study. Laboratory work made up a significant part of study of these modules (up to 50% for the GPA), but there was no assessed coursework. In later years three additional (optional) special modules were added in Vibration Control, Measurement and Instrumentation, and Sound Reproduction, and course work assignments were included in the assessment of the modules. These arrangements persisted until a major restructuring of the Diploma in 2008, which will be described later.

1.1 Responding to Change

Although the laws of physics and acoustics have not changed since 1978 there have been very many changes in other aspects of noise control: in the instrumentation available for the measurement of noise and vibration (in particular the introduction of digital signal processing); in methods of noise control (e.g. active noise and vibration control); in computerised noise prediction methods; in legislation, regulations, standards, and codes of practice relating to the control of noise. The Diploma course has developed to respond to all of these changes.

Since its introduction over 2000 candidates have gained the Diploma and have gone on to become corporate members of the Institute. The course is aimed at all who are, or wish to wish to be professionally employed in the fields of acoustics and noise control and has attracted delegates from a wide range of backgrounds including engineers and technicians (particularly mechanical, production and building services engineers), mathematicians, physicists and other scientists, architects, builders, acoustic and environmental consultancies and local authority environmental health practitioners, audio and sound reproduction technologists and engineers.

1.2 The revised Diploma 2008

The Diploma was restructured in 2008 to respond to changes in the national assessment and rating requirements of higher education, and to secure the postgraduate status of the Diploma in order to provide better opportunities for further study for future Diploma holders, and also to rationalise the delivery of the modules. The Vibration Control, Measurement and Instrumentation, and Sound Reproduction special modules, which had attracted only a small minority of candidates, were discontinued and their content incorporated into four new specialist modules: Architectural and Building Acoustics (ABA), Environmental Noise - measurement, prediction and control (EN), Noise and Vibration Control engineering (NVCE), and the Regulation and Assessment of Noise (RAN). The content of the GPA module was revised and extended, and the extensive programme of laboratory exercises were built into a Laboratory Module, and the Project arrangements were revised.

In addition the format of the examinations was revised to include a short section of compulsory short questions in addition to the usual selection of optional longer questions.

1.3 Credit Rating of the revised Diploma

It is considered by the IOA Education committee that following the restructuring in 2008 the Diploma has a credit transfer rating of 90 credits (at level M) with the nominal ratings of individual components as follows:

Principles of Acoustics	30
Laboratory Module	10

Each Specialist Module	15
Project	20

Students may be able use their Diploma to gain entry into various MSc courses in acoustics, with exemptions to some a parts of the programme amounting in some cases to direct entry into the second year of a two years part time Masters programme.

1.4 The Diploma approach

The Diploma course aims to teach the practical application of acoustic principles to the control of noise. Most of the course members are working in this area for example in local authority environmental health departments, or with acoustic consultancy practices, and so the course is able to connect directly with their day to day activities, and in turn they are able to enrich the course by sharing these experiences during class discussions. Therefore it is the applications of theory which are emphasised rather than the detailed derivation of formulae, although such derivations are always available to those students who wish to explore them. Emphasise is also placed on the assumptions of various theories and formulae because it is these that set the limitations of their validity when applied to practical situations. The course teaches various noise level prediction methods based on simplified and idealised models of noise propagation (free field, inverse square law, diffuse sound fields for example) which are the basis of current practice and the limitations of these assumptions in practice are discussed. This emphasis on the practical applications underlies all aspects of the Diploma course: teaching, assignments, laboratory work, examinations and project.

2 Module Content

2.1 The General Principles of Acoustics Module

This is the introductory and compulsory Module and the foundation of Diploma study. The nature and behaviour of sound: frequency wavelength and sound velocity, sound pressure, intensity and power. The decibel scale: sound power level, sound intensity level and sound pressure level. Sound propagation: the inverse square law and prediction of free field sound propagation. The behaviour of sound waves: interference, reflection, refraction, and application to sound propagation outdoors and indoors. Near and far fields of sound sources, and directivity.

The behaviour of sound in rooms and other enclosed spaces: wave, ray and statistical approaches to room acoustics. Sabine acoustics, direct and reverberant sound and reverberation time, Sabine's equation. Sound transmission between enclosed spaces, and between inside and outside: sound reduction index, mass law. panel resonances and coincidence, double leaf partitions; airborne and impact sound insulation.

Vibration and structure borne sound transmission: vibration displacement, velocity and acceleration. The theory of a one degree of freedom mass-spring-damper vibrating system; free and forced vibration, natural frequency, resonance, and the effects of damping. The application to simple theory of vibration isolation, transmissibility.

The measurement of sound and vibration: microphones and sound level meters; their construction, properties and performance criteria; sensitivity, frequency response, linearity dynamic range. Calibration. The use of sound level meters, and principles of good sound measurement technique. Frequency weightings and frequency analysis; time weightings: F and S. The measurement of time varying noise: LAeq, Lmax LA10 and LA90. The measurement of noise in the environment and in the workplace and indoors. Building acoustics measurement: reverberation time and airborne and impact sound insulation. Uncertainty in measurements. Measurement of vibration: accelerometers and vibration meters and principles of use, calibration, attachment of accelerometers to vibrating surfaces.

Human response to sound and vibration, The ear and hearing, loudness, equal loudness contours, frequency weighting curves, phons. Hearing disorders, conductive and sensori-neural hearing loss, presbycusis, noise induced hearing loss. Audiometry. Control of noise exposure in the workplace: Action Values and Exposure Limits, use of hearing protectors.

2.2 The Architectural and Building Acoustics Module

This module builds upon the GPA with further more detailed consideration of the theory and practice of room acoustics and sound insulation. The specific acoustics requirements of different types of space are considered, for example background noise level, reverberation time, speech intelligibility and privacy and the establishment of suitable criteria in each case, and how these criteria might be achieved through design of the space including shape, volume, and distribution of sound reflecting, absorbing or diffusing materials and surfaces, and separation and /or insulation from other spaces and noise sources.

The types of different spaces considered might include, for example: homes (living rooms and bedrooms), offices, school classrooms, performance spaces (theatres concert halls etc.), workplaces, rooms for public and private meetings, places of religious worship, restaurants, cinemas, specialist acoustic test rooms (anechoic, reverberant, audiometric), recording studios for radio and TV.

Other topics include: Special acoustic parameters for evaluating acoustic of performance spaces, acoustic modelling of spaces (ray and beam tracing methods), noise from building services, remedial design to achieve improved sound insulation: isolated walls, floating floors, suspended ceilings and box in box spaces, use of electroacoustic techniques.

2.3 The Noise and Vibration Control Engineering Module

This module also builds on the material covered in GPA to consider methods of noise control relating to the source, transmission path, and receiver. Consideration of the mechanisms by which sound may be generated from vibrating surfaces, from impacts and from aerodynamic

sources leads to a review of ways in which noise control at source may be achieved. The principles of sound absorption, insulation and isolation, introduced in the GPA are reviewed, studied in further detail and applied to the design of standard noise control measures such as enclosures silencers and barriers. The ability to diagnose sound sources and transmission paths and to predict noise level from various sources are important aspects of noise control and are discussed in this module. Other aspects covered include noise from fans and ducts in ventilation systems, noise from jets and exhausts, reactive silencers and active noise control. Specification and measurement of noise emission from machinery and of performance of noise control measures.

2.4 The Environmental Noise Module

This is an expansion of the previous Transportation noise module to include all types of environmental noise. It covers noise from: road rail and air transport; noise from industry and commerce; from mineral, landfill and construction and demolition sites; from wind turbines and from entertainment and other leisure activities. In all case the prediction, measurement, assessment and control of various types of noise are reviewed. The module includes a review of standards codes and regulations governing control of environmental noise, of the various measures of environmental noise exposure and of current guidance on impacts on human health of exposure to environmental noise; the environmental noise directive, environmental noise regulations, noise mapping, action plans.

2.5 The Regulation and Assessment of Noise Module

Overview of the European and UK National Policy on environmental noise; review of neighbour and neighbourhood noise; Impact of Planning and Building Control legislation on environmental noise; overview of legal and administrative frameworks; the role of noise prediction and mapping for the control and assessment of environmental noise; Introduction to Environmental Impact Assessment (EIA); Integrated Pollution Prevention Control (IPPC); Noise and Vibration at Work; Vibration.

Full details of all these syllabuses including learning outcomes, learning objectives, acquired / transferable skills and Indicative content may be found on the IOA website, which also includes a list of Standard Codes and Regulatory documents applicable to the study of each module.

2.6 Project Module

The purpose of the Project is to enable the student to demonstrate the use of the skills and knowledge gained during the course in successfully carrying out an investigation to solve and report an acoustics related problem, within a specified time scale.
Since the student will spend considerately time and effort in their project investigation the choice of topic is usually left to him / her, guided by his / her tutor.
Most projects are practically based and will involve some or all of the following stages: selection of topic area, research and literature survey, definition of aims and objectives, formulation of a methodology and time schedule for execution, gathering of data (noise and /or vibration measurements), analysis of data, formulation of proposals, implementation, testing, report writing.

A list of titles of successfully completed projects is printed each year in the Acoustics Bulletin (the bi-monthly IOA members magazine), and also in the current version of the Diploma Handbook for students.

An example list of project titles for one academic year is given at the end of this presentation, to demonstrate the wide variety of topics which have been investigated.

2.7 Laboratory Module

Although there will be some variation between different Diploma Centres the programme of lab work will include a core of common experiments including: Use of sound level meter to measure spectral based noise indices, NC, dBA, dBC and environmental noise parameters for time varying noise; building acoustics measurements: reverberation time, absorption coefficient, field measurement of airborne and impact sound insulation of walls and floors, measurement of sound power levels, measurement of vibration levels, evaluation of loudness and plotting of equal loudness contours, audiometry, performance of barriers and enclosures, standing waves and room modes, speech intelligibility, FFT analysis, sound propagation (level v distance from source) indoors and outdoors.

Students are required to keep a log book recording details of all experiments undertaken, and to formally write a report of FOUR selected experiment for assessment purposes.

Modern sound measurement equipment is complex and although it is important to be able to use such equipment competently there are even more important underlying skills of good measurement procedure such as calibration where when and what (noise parameter) etc. Emphasis in the laboratory module is therefore placed on good measurement techniques rather than just the ability to programme and press the right sequence of buttons.

3 Assessment of the Modules

Each of the taught modules is assessed by a combination of examination (60%) and assignments (40%). The assessment of the laboratory module is based on the quality of three written lab reports (90%) and of the lab notebook (10%), and for the project on the quality of the final report (80%) and of the project logbook (10%) and the initial project proposal (10%). Copies of the past three years examination papers are made available to all students. Each candidate is informed privately of his/her module results at the beginning of September each year. A Chief Examiners report containing an overview of the results for all centres is published each year in the Acoustics Bulletin.

A course handbook (separate versions for centre based and distance learning study) is issued to all students which contains information about all aspects of studying the Diploma including details of the assessment procedures.

3.1 Assignments

Students are required to complete two written Assignments as part of the GPA Module and one for each special Module completed. These assignments although part of the course assessment process are designed to add to the quality of the students learning experience.

One of the GPA Assignments usually involves an extended exercise involving a design calculation on some aspect of the syllabus, and the other assignment requires the student to research some aspect of acoustics which is not central to the syllabus. In the past students have been required to investigate: the calculation of noise radiation from a process plant installation, acoustics issues in schools, noise from glass bottle handling, underwater sound exposure of marine mammals, building acoustics, non-auditory effects of noise on human health, environmental noise and its assessment; noise from a small wind turbine, outdoor sound propagation, the acoustics of woodwind musical instruments

The special module Assignments are written by specialist module examiners who are specialist in their field. Subjects have included:

ABA Module: Aspects of concert Hall design, design of sound insulation of building conversions to meet Building Regulations requirements, Acoustic design of a building and of a housing estate, measurement of sound insulation requirements to satisfy ISO 140

NVC Module: Performance of acoustic enclosures, Noise impact assessment from a pumping station, assessment of noise from a sewage treatment plant, Assessment of noise impact from Widgit engineering, Helicopter noise transmission, control of noise and vibration from a floor mounted machine.

EN Module: Noise from a new tramway system (airborne noise impact assessment), noise from minerals extraction (code of practice), the assessment of construction noise, assessment of vibration from railways,

RAN Module: Assessment of vibration from railways, Environmental noise directive and noise action plans, Wind farm noise, Dose effect relationships for night-time noise, EU Physical Agents Directive and the Noise at Work 2005 Regulations.

4 The Tutor supported Distance Learning Mode of Study

For prospective candidates in regions where Centre-based courses are not available, or, in principle, for any candidate who can show due reason why he or she is unable to make use of an Accredited Centre in the usual way, there is a Tutored Distance Learning Scheme.

Distance Learning students are provided with a comprehensive set of printed notes for each module that they study and are allocated a course Tutor with whom they may contact by email, phone, or face to face at tutorial sessions. As well as presenting the tutorials the tutor will be responsible for marking their GPA assignments and choice of specialist modules and act as Tutor for their project work i.e. provide guidance with selection of project topic, continued support throughout including feedback on draft and final assessment of final report.

The GPA notes are divided into 10 study units: 1 Basic concepts and principles 2 measurement of time varying noise and calculation of noise indices 3 the ear and hearing, 4 sound propagation 5 sound absorbers and room acoustics 6 sound insulation 7 vibration, 8 Measurement and instrumentation, 9 Noise control 10 review and revision,

A programme of 10 days of tutorial support is provided each year (October to May) consisting of 5 days for the GPA Module, so that two units are covered in each tutorial session, two days for each specialist module and a revision tutorial before the examinations in May.

The Distance learning notes for the specialist modules also provide comprehensive coverage of the syllabus material and each contains a reference to material for further detailed study if required, and in the case of the building acoustics and noise control modules a number of case studies are included.

Although they are optional the tutorials are usually well attended. As well as receiving help and advice from the tutor these sessions also provide an invaluable opportunity for the students to meet each other, to discuss the course and exchange experiences, and this process is encouraged so that the class may set up their own self support groups. . This process continues at the laboratory sessions. There is much invaluable learning material available on line at various websites which can greatly enhance the material in the printed notes and the distance learning students are encouraged to use this as a learning source. They are also provided with past examination papers which they are encourages to use as a learning resource throughout the year, and not just as an aid to examination revision.

Distance learning students must attend a total of four days laboratory classes at Liverpool (usually two sessions of two days each in November/ December and January / February). During this period they complete eight laboratory exercises, and must keep a log book of all and write a full report on four of them.

Students from outside the UK may also study for the diploma by Distance learning provided that they are also able to attend the 4 days of laboratory sessions(or where in exceptional cases arrangements can be made to do the lab work in their own country). The may join the tutorial sessions via the internet and have contact with their tutor by email and by telephone. Students from Dubai, Malaysia, Hong Kong, New Zealand and South Africa have studied the Diploma in this way.

The requirements for the award of the Diploma are exactly the same for Distance learning candidates as for all other students attending week by week at recognised diploma centres, ir the same examinations assignments and laboratory work and project requirements..

5 Course Results

Table 1 presents results (% pass rates) for each module for the last nine years, taken from the Chief Examiners report published each year in the Acoustics Bulletin . Also shown ( ) are the number of candidates each year sitting the GPA examination. Note that exam FAILS include candidates who were absent from the written examinations, and Project FAILS include candidates who did not submit their Projects.

6 Opportunities provided by the Diploma course

Many students study the Diploma whilst working in acoustic to improve their skills and knowledge as a form of career enhancement and to become corporate members of the IOA. Many job vacancies in acoustics specify the holding of a Diploma as a necessary condition of application. Other candidates not working in the field join the course to gain employment in acoustics as a career change and are successful. Others have used the Diploma as a pathway to further study for an MSc degree, and in a few cases for PhD study.

Diploma graduates who obtain three Merits (including a merit in the GPA module) may be considered to have met the M-level educational requirements for achieving Chartered Engineer (CEng)status through the IOA. This will require also that candidates have an accredited three year degree in a relevant subject (or equivalent qualification).

7 Access and Recruitment

The normal minimum requirement for admission to the Diploma in Acoustics and Noise Control is a degree in a science, engineering or construction-related subject or an Environmental Health Officer's Diploma. However as part of the Institute's policy of open access alternative qualifications, with related professional experience, may be acceptable and will be considered on a case-by-case basis. Although the course is promoted by the IOA and the individual centres in the usual ways much recruitment is by word of mouth recommendation. Many past students have studied the Diploma whilst at a junior level in their careers and have as their careers progressed subsequently over several years have sent colleagues to study the course.

8 Course Administration and Quality Control

The responsibility for maintaining the quality of the Diploma lies with the Education Committee of the IA which is ultimately responsible to Council. The day to day administration is carried out by full time staff at IOA headquarters with academic support from the IOA Education Manager. A board of examiners consisting of a Chief examiner, Deputy chief examiner, specialist module examiners supported by the Education Manager is appointed by the Education Committed to directly oversee the assessment of the Diploma.

9 Conclusions

Over more than 35 years the Diploma course has successfully responded to many changes in the practice of acoustics and noise control but and still fulfils essentially the same purpose for which it was introduced to provide basic education and training in for those seeking a career in acoustics and noise control, and a route towards corporate membership of the IOA. It has also served as a route into employment in acoustics and noise control for many seeking a change of career opportunity as well as a pathway to study for MSc and in some cases PhD studies. The Institutes commitment to open access and the introduction of the Distance learning option have significantly increased access to these opportunities.

Disclaimer

The views expressed in this paper are entirely those of the author, and not necessarily those of the Institute of Acoustics.

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Bibliography

IOA Diploma Course Handbook 2011/12
IOA website: www:ioa.org.uk
IOA Bulletin (Examiners annual presentations of course results)_

Project Titles for year 2010-11

Treatment of a Studio live room on a budget

Enclosure design and calculated insertion loss
Noise risks to cyclists
Reverberation time: measurement vs prediction
The inference of varying background noise on sound insulation measurement
Methods of Lmax analysis for external building fabric design within city environment
Noise exposure of employees in a garage workshop
The sound of silence
Assessment and performance maximisation of Sonata Acoustics porous absorbers
Occupational noise control

A review of combined road traffic noise levels form A4 and M4 in Brentford using DEFRA noise maps
Are we aware of the effects if sub physical damage through stress induced by noise?
Hyde Park Concert Noise monitoring and minimising complaints
Evaluation of performance of a roadside barrier: A comparison of objective and subjective data
An investigation into the noise produced from deliveries to supermarkets

Acoustic treatment to improve sound reproduction in a small room for the purpose of mixing recorded music
A development and commissioning process of a large sliding acoustic door
An investigation into the noise impact of anaerobic digestion facilities

The acoustic treatment of a home studio
Noise impact from the Adhan
Suitability of static exhaust test using Lmax on motorcycle tracks
A study for the desirable acoustic features of a home cinema room
Analysing the acoustics of Cannonball Studios
Recording studio acoustics; a case study
The accuracy of façade correction values and the free-field representative distance
An investigation into noise exposure levels in a children's play facility
College rock/pop venue analysis
Noise abatement technology on heavy plant in surface coal extraction
Noise contour map of licensed premises in Kingston upon Hull
The acoustic treatment and measurement of an acoustic listening space
An investigation into low frequency noise

Variations in acoustical feature of a New Born Baby's Cry
Predicting, measuring and assessing noise from a Robinson R22 Helicopter
An investigation into the effect of damping on different thicknesses of metal
Investigation into the effect of paper on notice boards absorption
Performance of micro-perforated panel absorbers
Uncertainties of employing light aircraft certification to estimate actual noise exposure
The impact of road traffic noise arising from development within established residential areas
Investigation into the implications of the use of an acoustic screen to manage drum noise
An extreme environment stethoscope
Development of practical exercises to investigate the characteristics of side branch resonators

Hearing protection in the live event industry
Movable walls: production methodology
Noise levels from Kerbside glass collection
Drive-by test at Donington Race track
Suitability of BB93 to assess existing buildings
Critical assessment of noise impact of bird scarers
Friction modifers and acoustic roughness of rails
Tonal correction feature of BS4142
Classroom acoustics and BB93
Comparison of predicted and measured reverberation time
Airborne noise and impact testing
Measurement of low level noise
Drifting at Santa Pod raceway
Assessment of perception of movable walls
Speech intelligibility in Masonic temples
Relationship between music type and annoyance
Noise impact of night time deliveries

Assessment of the effect of acoustic reflection attributed to a façade

Effects of splitting a single sound source into two from diesel engine
Characterisation of diesel power generator set
Noise levels at 2 domestic dwellings in the vicinity of the M1 motorway
An acoustic evaluation of a two-storey entertainment venue
2 stroke v 4 stroke lawnmowers
Occupational noise exposure of workshop employees
Noise nuisance arising from concrete batching plant
Evaluation of acoustic treatment in a multi-purpose concrete plant
Assessment of hearing damage in meat processing factory

A low cost field investigation into the effect that void depth has on the sound absorption of suspended ceiling tiles
Comparison of the noise levels inside a vehicle for two different concrete road surfaces
The variance in the acoustics performance of studio theatres for different stage formats
Building and Commissioning an Acoustics Laboratory
The guitar as a vibrating system
An investigation into the location of a returns air grille in a fan coil unit system
Airborne and Impact Sound Insulation of Lightweight Floor and Ceiling Constructions
The Comparison of Road Traffic Noise Measurement
Street Noise at Varying Heights Due to Urban Canyon Width

Investigation and comparison of CRTN with WHO guidelines for community noise, using internal and external property measurements
The impact of the smoking ban on the noise pubs and clubs in South Tyneside
Investigation into the Acoustic Directivity of a Small Wind Turbine
The effect of wind direction on long term predictions of wind farm noise
Effects of Anthropogenic Noise on Protected Species
Effectiveness of Prototype Silencer of Leisure Motorbike
Propagation of Noise from Wind-Turbines

Table 1 Module Pass rates (%) for years 2003 to 201, with numbers of candidates taking the GPA Module examination ( ) also shown.

	GPA	PROJ	ABA	RAN/LA	NCE	EN/TN
2011	83 (110)	70	89	73	76	81
2010	68 (134)	64	72	72	66	86
2009	78 (144)	75	76	72	82	77
2008	90 (153)	85	87	85	85	80
2007	82 (137)	81	74	79	85	91
2006	79 (172)	79	74	84	75	84
2005	74 (145)	66	80	76	79	77
2004	83 (150)	82	83	74	76	74
2003	80 (138)	76	80	72	66	78