Ensure you and your company remain at the forefront of Industrial Automation

Join the next generation of automation engineers
Through innovative e-learning, participate from your home or office

WHAT YOU WILL GAIN:

• Skills and know-how in the latest technologies in instrumentation, process control and industrial automation
• Guidance from industrial automation experts in the field
• Knowledge from the extensive experience of instructors, rather than from the clinical information gained from books and college
• Credibility as the local industrial automation expert in your firm
• Networking contacts in the industry
• Improved career prospects and income
• An IDC Advanced Diploma of Industrial Automation
INTRODUCTION

Join the next generation of automation engineers. Embrace a well paid, intensive yet enjoyable career by taking this comprehensive and practical course. It is delivered by live distance learning and presented by some of the leading automation, instrumentation and control engineering instructors in the world today.

There is a critical shortage of automation, instrumentation and control engineers around the world now due to retirement, restructuring and rapid growth in new industries and technologies. The respected ISA organisation estimated that at least 15,000 new automation engineers are needed annually in the US, alone. Many industrial automation businesses throughout the world comment on the difficulty in finding experienced automation engineers despite paying outstanding salaries. For example, about five years ago a gaping hole appeared and remains with control valve specialists being few and far between.

Often universities and colleges do not teach industrial automation as a core subject and much of the key training material (E.g. practical instrumentation and valve topics) necessary to arm you when commencing work as a successful automation, control and instrumentation engineer is missing from their curriculums. However, there are a few notable exceptions with some highly dedicated practitioners.

Many of those universities and colleges that do teach industrial automation and control do so mainly from a theoretical point of view. Furthermore, lecturers often have little experience in industry due to the difficulty in attracting good engineers from the highly paid private sector.

The aim of this 18 month e-learning programme is to provide you with core industrial automation skills. The topics that will be covered are derived from the acclaimed IDC Technologies’ courses attended by over 150,000 engineers and technicians during the past 15 years. There are seven threads running through the course to give you maximum, practical coverage in the field of industrial automation. These threads comprise of Instrumentation, Automation and Process Control, Electrical Engineering, Electronics, Industrial Data Communications, Process Plant Layout, Project and Financial Management and Chemical Engineering.

This practical course avoids too much emphasis on theory. This is rarely needed in the real world of industry where time is short and immediate results, with hard-hitting and useful know-how, are required as a minimal requirement.

The instructors presenting this advanced diploma are highly experienced engineers from industry who have done the hard yards and worked in the trenches in the automation, instrumentation and control areas.

The format of presentation - live, interactive distance learning with the use of remote labs means that you can hit the ground running and be of immediate benefit to your company or future employer.

IDC TECHNOLOGIES’ ACCREDITATION STATUS

IDC Technologies is an internationally endorsed Professional Training Organisation.

This Advanced Diploma is accredited within the Australian Qualifications Framework (AQF Code 51935), by the Training Accreditation Council (TAC) - the national leader in the strategic management of the recognition and quality assurance of training. Information may be found at http://www.aqf.edu.au/intemat.htm. Furthermore, IDC Technologies is a Registered Training Organisation (RTO) in Australia - National Provider Number – 51971.

It is very important to us to ensure that our clients can confidently complete our courses knowing that the professional development they are receiving is of a creditable standard and will provide them with personal, measurable, productivity gains and the opportunity for career advancement.

To date IDC Technologies has received endorsement and/or validation from the following authorising bodies: The Institution of Engineering and Technology, which has more than 150,000 members worldwide - the largest professional engineering society in Europe and the second largest of its type in the world. The Institute of Measurement and Control in the United Kingdom, which is Britain’s foremost professional body for the Automation Industry. The Project Management Institute in the USA, which has more than 265,000 members in over 170 countries. The Training Accreditation Council in Australia, which is the national leader in the strategic management of the recognition and quality assurance of training. Engineers Australia, which is the national peak body for all engineering disciplines. It represents 80,000 members.

The Engineering Council of South Africa. Board of Engineers – Malaysia.

If you need more information regarding the status of this Advanced Diploma please do not hesitate to contact the Course Coordinator through your local IDC office.

Benefits of E-learning

- Upgrade your skills and refresh your knowledge without having to take valuable time away from work
- Receive information and materials in small, easy to digest sections
- Learn while you travel - all you need is an Internet connection
- Have constant support from your course instructor and coordinator for the duration of the course
- Interact and network with participants from around the globe and gain valuable insight into international practice
- Receive an IDC Diploma of Industrial Automation for CPD purposes

Who Should Attend

Anyone who wants to gain solid knowledge of the key elements of industrial automation to improve their work skills and to further their job prospects:

- Electrical Engineers and Electricians
- Maintenance Engineers and Supervisors
- Energy Management Consultants
- Automation and Process Engineers
- Design Engineers
- Project Managers
- Instrument Fitters and Instrumentation Engineers
- Consulting Engineers
- Production Managers
- Chemical and Mechanical Engineers
- Instrument and Process Control Technicians

Even those who are highly experienced in industrial automation may find it useful to attend some of the topics to gain know-how in a very concentrated but practical format.

Prior Learning Recognition and Exemptions

If you are knowledgeable and experienced in a particular module; we can give you credit for that module. One of our staff will do a one-on-one interview with you to evaluate your knowledge on the particular module. This will be done in a friendly, non-confrontational atmosphere.

To register please contact info@controlsacademy.com
The programme features real-world applications and uses a multi-pronged approach involving interactive on-line webcasts, simulation software and self-study assignments with a mentor on call.

The course consists of 72 topics delivered over a period of 18 months. Presentations and group discussions will be conducted using a live, interactive software system. For each topic you will have an initial reading assignment [which will be delivered to you in electronic format in advance of the online presentations]. There will be coursework or problems to be submitted and in some cases there will be practical exercises, using simulation software and remote labs that you can easily do from your home or office.

You will have ongoing support from the instructors via phone, fax and e-mail.

Live Webcasts

During the programme you will participate in 72 live interactive sessions/webcasts with the instructors and other participants from around the world. Each webcast will be scheduled at 2 varying session times, so that you can select the one which is most convenient to you. Webcast times are only finalised after registrations close, as we need to know which time-zones all participants are based in before we can compile a schedule. Upon registration you will receive a questionnaire regarding your time availability. We guarantee that at least one session time, for each webcast, will fall into your preferred time slot.

For more information or to register, please contact:
info@controlsacademy.com

Practical Exercises and Remote Laboratories

As part of the groundbreaking new way of teaching, we will be using a series of remote laboratories [labs] and simulation software, to facilitate your learning and to test the knowledge you gain during the course. These involve complete working labs set up at various locations of the world into which you will be able to log and proceed through the various practical sessions. These will be supplemented by simulation software, running either remotely or on your computer, to ensure you gain the requisite hands-on experience. No one can learn much solely from lectures, the labs and simulation software are designed to increase the absorption of the materials and to give you a practical orientation of the learning experience.

All this will give you a solid, practical exposure to the key principles covered in the course and will ensure that you obtain maximum benefit from the course to succeed in your future career in Industrial Automation.
We are Flexible with your Commitments

We recognise that personal circumstances can make it difficult to complete the course in the time available. We will be flexible about the time you require to complete the course. We will guarantee you access to the resources for a period of 3 years, from the commencement of the course in order to complete the diploma.

You can withdraw from the course at any time and receive a Certificate for the topics you have completed. However, completion of all 72 topics will earn you the IDC Diploma of Industrial Automation.
International Expert Speaker Faculty

Your team of professional presenters and facilitators are drawn from experts in their field. They will work closely with you for the duration of the course.

Guest Speaker and Advisory Panel

RICHARD E. MORLEY

Richard E. Morley, best known as the father of the Programmable Logic Controller (PLC), is a leading visionary in the field of advanced technological developments. Mr. Morley (Dick) is a member on the Board of Directors of various companies across the United States and has worked in high tech industries since the beginning of solid-state electronics.

He is currently Chairman of the Board of NCMS (National Center for Manufacturing Sciences) and has a proven track record in the founding of successful high-tech companies for where he provides initial product concept and a continuing technological presence.

He is a nationally recognized expert in the field of computer design, artificial intelligence, automation and is an authority on the factory of the future. Mr. Morley is an engineer, consultant and inventor. His inventions include the PLC (Programmable Logic Controller), which now stands in the Smithsonian Institute. He holds more than twenty United States and foreign patents. Mr. Morley is well known as a lecturer, has written extensively for such publications as Manufacturing Systems magazine and Manufacturing Automation magazine. He has published many works of his own. His latest book, 'Out of the Barn', was published in October 2002 and another book, 'The Technology Machine', was published in September 1999. Mr Morley founded the angel investment group; the Breakfast Club. He is currently an active member with this group of investors having participated in more than 100 startup companies in the New Hampshire area.

He was the former Director of Advanced Technologies for Gould, Inc. He is a Gould Fellow of Science and Engineering, a Fellow of SME, Bios LP and ICS. In addition, he was awarded the 1990 Entrepreneur of the Year by inc. magazine, Merrill Lynch and Ernst and Young.

He is a 1991 recipient of The Franklin Institute’s Howard N. Potts Medal, and holds the Prometheus Medal placing him into the Automation Hall of Fame. International IEN ranked him 3rd in the ‘Top 100 Most Significant Industrial Products of the 20th Century’ for his work with the PLC.

In October 1999, ISA (Instrumentation, Systems and Automation Society) honored him with the “Life Achievement Award” and Fortune magazine awarded him their “Heroes of Manufacturing Award” in March 2000.

Recognized as one of the giants in the field by the Engineering Society of Detroit, he has extensive experience in high-tech consulting and is involved in new product development at the highest management levels.

Currently he works out of his barn in New Hampshire where he and his wife have been home to more than two dozen foster children.

Programme Designer and Advisory Panel

Steve Mackay

CP Eng, FIE (Aust) BSc(ElecEng), BSc(Hons), MBA, MMIR
Technical Director, IDC Technologies

Steve has worked in engineering throughout Australia, Europe, Africa and North America for the past 30 years. He has presented numerous industrial automation and industrial data communications courses world-wide to over 19,000 engineers and technicians, and has a particular interest in practical and leading edge aspects of marketing, business and engineering practice.

He is a fellow of Engineers Australia and the technical director and founder of IDC Technologies, a growing engineering training and publishing firm which has been operating from offices throughout the world since 1992. He has also acted as the author or editor of over 30 engineering textbooks sold throughout the world. He feels that all engineering businesses need to think globally and keep experimenting with new approaches. He is currently leading a team of two design engineers and four programmers in creating a new video conferencing software package with remote labs which he believes will make a marked impact on engineering training.

Programme Director and Advisory Panel

Dr. Rodney Jacobs

NH Dip, M Dip Tech, BA (Hons), D Tech
Senior Instrumentation Engineer

Rodney has over 20 years experience in the gold mining industry, underground as well as specialising in Metallurgical operations in the Gold Plants. He has worked predominately in the instrumentation, process control and automation field, and is responsible for hardware and software designs associated with instrumentation. His areas of special interest include PLCs, SCADA systems, process control and programming. Having spent many years on the shop-floor, Rodney has built up a vast amount of hands-on practical experience.

Rodney is currently active as a Consulting Engineer in the field of instrumentation, both to the mining industry as well as to other general engineering companies, which require specialised solutions. He has also lectured in Electronics, Electrical Engineering and Digital Systems, at a university level. Rodney feels that people are the most important asset of any organisation and has a qualification in Psychology to complement his Engineering knowledge and experience.

Finally, Rodney has presented numerous IDC workshops in the United States, England, Ireland, Scotland, Bahrain, United Arab Emirates, Iran, South Africa, Australia, New Zealand and Malaysia.
Presenter

Ian Verhappen

BSc, P. Eng, ISA Fellow, ISA Certified Automation Professional

Ian has been involved in digital communications since 1994, installing the first multi-vendor Foundation Fieldbus project in 1996. Since then Ian has served as both a leading Project Engineer/Designer and an external/cold eyes review consultant for a number of companies involved in pulp and paper, mining, food processing, water and wastewater, oil sands processing, petrochemical and refining industries.

Ian is co-author, with Augusto Pereira, of ISA’s popular “Foundation Fieldbus Pocket Guide”. Also under Ian’s guidance as editor, is the Foundation Fieldbus End User Advisory Council’s “Engineering Design Guide, Foundation Fieldbus document AG-181”. This is the definitive guide for the complete life cycle for Fieldbus projects. The “Guide” has been translated into German, Japanese, Chinese and Russian, demonstrating how widely it is used as the basis for many corporate and project specifications. Ian is also an active volunteer with ISA, serving as Vice-President of the Standards and Practices 2005/6 and was also the person responsible for the formation of the ISA-100 Industrial Wireless committee on which he continues to participate. Ian is also heading up the Fieldbus Foundation’s High Speed Ethernet Remote I/O development team.

Ian is known as a digital communications evangelist and his passion for the topic has taken him around the world to share his experiences. Ian has the ability to explain technology in simple terms that can be understood by others without the same level of theory or experience, a rare quality! Ian’s seminars are less presentation than they are interactive conversations loaded with practical examples and experiences, his enthusiasm for the topic is contagious and leaves you not only more knowledgeable about the topic but excited to go ‘make it work’.

Presenter

Geoff Bottrell

HNC, DMS, MIEE
Senior Hazardous Areas Engineer

Geoff has been working in the instrumentation, measurement and control fields for over twenty-five years and has spent the past fifteen years specialising in Hazardous Areas, Intrinsic Safety and Instrumentation Drawings. Geoff began his career at Kent Instruments, as a service engineer working in both the UK and East Africa. His experience ranges from systems design functions, on-site trouble shooting to technical and commercial customer support.

Recently Geoff has taken on the responsibility of mentoring engineers in training, in addition to the presentation of engineering workshops in the process control and measurement field. His positive interactive style to teaching has made him popular with workshop attendees worldwide.

Presenter

George Marx

P. Eng, B.Sc (Eng)
Senior Electronics Engineer

Over the past 16 years, George has developed an extensive amount of experience in design work in power electronics and electro-optical systems and in surge protection, earthing and EMC experience in the military and commercial market.

George’s portfolio of achievements include EMC and Switch Mode Power Supply Design for high reliability military applications together with UPS, EMC, Power Supply, Servo Amplifier, Battery and Inverter Design for industrial systems, such as solar panel applications, vehicle management, specialised computer systems and design of a high current starter for vehicle plants. He is an enthusiastic instructor with a wealth of knowledge under his belt. Much can be gained from his entertaining style, as thousands of others have benefited from his knowledge.

Presenter

Dave Macdonald

BSc (Hons) Inst. Eng.
Senior Instrumentation Engineer

Throughout his career Dave has been involved in the application of instrumentation and control technology to industrial and chemical processes. As a senior instrument engineer in the UK and later with AECI Ltd in South Africa he was involved in managing the design and implementation projects for process control systems from conceptual design to commissioning.

Over the past 6 years Dave has specialised in the technology of risk reduction through the application of safety instrumented systems. He has worked as a training instructor and team leader for hazard studies and safety system reviews in chemical processing plants and boiler systems. With IDC Technologies he has developed several workshops to reflect recent developments in international best practices.

In the past few years, Dave has lectured on this and related topics to hundreds of Engineers and Technicians in Canada, the United Kingdom, Ireland, Australia and South Africa. His positive and enthusiastic approach combined with his broad knowledge of the subject makes this a not-to-be-missed learning experience.

Presenter

Ian McLean

Eur. Ing. Ian McLean B.Sc, C.Eng, FIEE, FIOSH (ret’d)
Senior Electrical Engineer

With over 40 years of experience under his belt, Ian has a wealth of experience and knowledge that he is eager to share. Ian started as a student apprentice but quickly moved up the ladder to join the Health and Safety Executive in the UK as HM Electrical Inspector. In this role he provided technical advice and appeared as an expert witness in Coroners, Magistrates and Crown Courts. Later, he acted as HM Principal Electrical inspector and became the head of the Power Systems and Ignition Hazards Section responsible for technical support and guidance for Major Hazards, Nuclear, Offshore and Railways Inspectorates. He was also a technical advisor on power engineering matters to the Channel Tunnel Safety Authority.

Ian has since retired from the HSE to focus on lecturing and giving technical guidance to organisations. You are sure to learn significantly from this passionate and enthusiastic instructor.
Kobus Harmse
B.Eng(Chem Eng), B.Eng Hons
Senior Technical Manager

One word describes Kobus. Passionate! He loves his work in chemical engineering. He has worked in a number of roles at Sasol in the chemical engineering area ranging from the ammonia business, to ultra high purity hydrogen and solvents. Latterly he’s been responsible for optimisation support in the Monomers and Polymers business. He spent a year doing detail engineering in Texas which he found a tremendously positive influence on his career.

Kobus has received outstanding reviews with his presentations of this course overseas; with many participants commenting on his strong practical bias thanks to his experiences in chemical engineering.

John Westover
BSc ChEng, M Eng Sci Process Integration

John has over 26 years of experience in the oil and gas industry, and his career has taken him from Rocky Mountains and the Arctic Coast of Alaska to various locations in Australia, with several stops in between. He has previously worked for both owner/operators such as Amoco and BP and the engineering company, Fluor and has first hand understanding of the unique needs and requirements of various stakeholders.

He first earned the respect of his operations and maintenance co-workers when he proved some thermocouples were not working properly – he had to wear a safety harness and climb a 35-tray distillation column outside the ladder cage to get some data [the data verified his theory].

After reaching the age of 40, John completed his Masters degree, specifically looking at how process integration could be systematically used to reduce the weight of offshore platforms (which resulted in a paper for the Society of Petroleum Engineer). Since then his career has started to transition into training and mentoring roles. He developed a practical course for Monash University, showing how the principles of Chemical Engineering taught in school could be applied to real engineering problems and has consistently been one of the most highly rated courses by the students. He also developed some remote training modules for operations and maintenance personnel for a facility expansion with new technology in Pakistan.

Nanda has extensive experience in teaching short, intense, review courses for engineering license exams in the USA and is a registered Professional Engineer (PE) in the State of Texas, USA. He is a passionate teacher who truly enjoys conveying complex technical concepts in a practical, down to earth manner. An effective communicator, Nanda receives excellent reviews from course participants.

Edward S. Meadows
PhD, PEng
Senior Consulting Engineer

Dr. Meadows is a chemical engineer with extensive experience in chemical process control and safety instrumented systems engineering. He is an expert in Advanced Process Control (APC) and is the author of over twenty papers on APC theory and applications. After graduating as a chemical engineer, Dr. Meadows served as a nuclear engineer on the staff of the Director of the Naval Nuclear Propulsion program.

Dr. Meadows turned to academics following his Naval experience and completed a doctorate in model predictive control using nonlinear models. His work substantially increased the theoretical understanding of APC by providing design conditions that could provide stabilising controller settings for APC implementations. He continued his research work on a 3-year teaching and research fellowship to Brazil, a research appointment at the University of Delaware, and a tenure-track position at the University of Alberta.

More recent work has been an emphasis on applications of APC for control of emulsion polymerization reactors and also for solid-oxide fuel cells. Dr Meadows has now joined Kenexis as a Senior Consulting Engineer and was instrumental in founding Kenexis ULC to bring the services and expertise of Kenexis to Alberta and Western Canada.

With his extensive experience in APC and excellent communication skills, you will walk away from this with valuable know-how.

Deon Reyners
Pr Eng, BSEE MBA
Senior Data Communications Engineer

Deon has had over 25 years experience in automation, data communications [with a focus on industrial applications] and Ethernet TCP/IP networks. He has specific experience in Systems Engineering, Project Management and software and hardware development. Currently he is retained as a consultant to industry in the TCP/IP, industrial Ethernet networking, OPC and the industrial data communications areas.

Deon is a practical, hands-on person and a highly entertaining speaker. He has received excellent reviews from his thousands of course participants in regions ranging from Europe, North America, Africa and Australia. He takes great pride in demystifying difficult concepts and presents them in a simple-to-understand manner. He is a passionate, enthusiastic and knowledgeable professional engineer. You will walk away from this workshop with a wealth of know-how which you can immediately apply to your work.

N.S. Nandagopal
B.Sc [Chem Eng], M.Sc, PE.
Chemical Engineering Consultant

Nanda has over twenty-five years of industry and academic experience in the areas of process plant layout and piping design. His experience includes work in process design, plant design, pipe stress analysis, and piping engineering and design. While at Brown and Root, Nanda designed and engineered major piping systems for offshore platforms; including high temperature and high-pressure lines. He has served on the Board of Directors of Society of Piping Engineers and Designers (SPED) and is constantly in touch with the trends and current practices in process plant and piping design.

Nanda has extensive experience in teaching short, intense, review courses for engineering license exams in the USA and is a registered Professional Engineer (PE) in the State of Texas, USA. He is a passionate teacher who truly enjoys conveying complex technical concepts in a practical, down to earth manner. An effective communicator, Nanda receives excellent reviews from course participants.

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Module 1: **Practical Instrumentation for Automation and Process Control**

You will Learn How to:
- Specify and design instrumentation systems for:
  - pressure
  - level
  - temperature
  - flow measurement
- Apply your knowledge of instrumentation and control valves
- Install process equipment correctly
- Understand the problems with installing measurement equipment
- Troubleshoot instrumentation systems and control valves
- Understand the major technologies used for instrumentation and control valves
- Isolate and rectify instrumentation faults

**Overview**

These topics are designed for engineers and technicians who need to have practical knowledge of selection, installation and commissioning of industrial instrumentation and control valves.

In many respects a clear understanding and application of these principles is the most important factor in an efficient process control system. You can only achieve excellent control of your process when your instrumentation provides the correct information. You will learn how to achieve effective results for the industrial processes you are responsible for, including the design, specification and implementation of control and measurement equipment. The material focuses on real applications, with attention to special installation considerations and application limitations when selecting or installing different measurement or control equipment.

**Practical Sessions**

This course provides practical hands-on configuration of industrial instrumentation and highlights both the ease of setting up equipment and the traps and pitfalls that are often encountered.

*Practical sessions include:*
- Process calibration using various standard equipment
- Span and zero configuration
- Sizing and selection calculations
- Diagnostic tools
- 4-20 mA process simulation

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**THE PROGRAM**

**Topic 1.1**
**INTRODUCTION**
- Basic concepts
- Definitions
- Overview of pressure, level, temperature and flow
- Overview of valves

**Topic 1.2**
**PRESSURE MEASUREMENT**
- Principles
- Sources
- Transducers and elements
- Specifications
- Installation issues

**Topic 1.3**
**LEVEL MEASUREMENT**
- Principles
- Simple sight glasses
- Buoyancy tape systems
- Hydrostatic pressure
- Ultrasonic measurement
- Radiation measurement
- Electrical measurement
- Density measurement
- Installation issues

**Topic 1.4**
**TEMPERATURE MEASUREMENT**
- Principles
- Thermocouples
- Resistance temperature detectors
- Thermistors
- Liquid-in-glass, filled, bimetallic
- Pyrometers
- Installation issues

**Topic 1.5**
**FLOW MEASUREMENT**
- Principles
- Differential pressure flowmeters
- Open channel flow measurement
- Oscillatory flow measurement
- Magnetic flow measurement
- Positive displacement
- Ultrasonic flow measurement
- Mass flow measurement
- Installation issues

**Topic 1.6**
**PROCESS CONSIDERATIONS**
- Transmitters
- Noise
- Material of construction

**INTEGRATION OF THE SYSTEM**
- Individual instrument error and total error
- Testing and commissioning
Module 2: Control Valve Sizing, Selection and Maintenance

You will Learn How to:

- Understand what happens inside a control valve from basic fluid mechanics point of view
- Appreciate the difference between cavitation and flashing, and know what choked flow is
- Do simple calculations to determine CV values
- Recognise severe service applications and have an appreciation for the methods of tackling the problems associated with such applications
- Identify the different types of control valves commonly in use and understand the relative advantages of each
- Choose between different characteristics on offer and specify seat leakage rates
- Select size actuators for linear and rotary applications and know the relative advantages of pneumatic, hydraulic and electric types
- Select materials for bodies, trims, packing boxes, and gaskets
- Make use of a computer sizing program to assist with the selection of control valves
- Understand the failure modes for control valves and demonstrate new approaches to troubleshooting

Overview

It is claimed that the majority of control valves throughout the world have not been correctly sized and that large numbers operate on manual mode. Whether this is true or not is difficult to establish but we do know that the method of sizing and selecting a control valve for a specific application is generally not well understood. Although there are many factors that need to be taken into account the subject is not difficult to understand if dealt with in a logical manner. We also find that many maintenance problems result from people treating the symptoms of a problem rather than tackling the true cause - a basic understanding of the principles is all that is usually needed to solve the problem for good.

Training Methodology

The latest educational methods and strategies will be employed. This module is designed to maximise benefits from the outset. Questions are encouraged throughout to provide you with the opportunity to discuss with the presenter and others, specific problems and appropriate solutions.

THE PROGRAM

Topic 2.1 INTRODUCTION TO CONTROL VALVE THEORY

- Introduction
- Definition of a control valve
- Energy types
- What is happening inside a control valve
- Cavitation
- Flashing
- Choked flow
- Valve Coefficient Cv

DIFFERENT TYPES OF CONTROL VALVES

- Globe valves
- Butterfly
- Eccentric disk
- Ball
- Rotary Plug
- Diaphragm and pinch

CHARACTERISTICS

- Equal percent
- Linear
- Quick opening
- Selection method

Topic 2.2 HIGH PRESSURE DROP APPLICATIONS

- Cavitation control
- Cavitation elimination
- Low noise
- Diffuser plates
- Chokes
- Disk stack technology
- Pressure balanced trim

USE OF COMPUTER PROGRAM FOR VALVE SIZING

EXAMPLES OF HIGH PRESSURE DROP APPLICATIONS

- Water - pump bypass
- Steam - turbine bypass
- Gas - pressure reducing
- Oil - choke valve

ACTUATORS

- Pneumatic
- Hydraulic
- Electric
- Sizing on rotary valves
- Sizing on linear valves
- Mounting considerations
- Manual overrides
- Accessories

POSITIONERS

- Basic principles
- Conventional pneumatic
- Conventional electro-pneumatic
- Smart positioners
- Feedback options

PNEUMATIC CIRCUITS

- Volume tank fail system
- Fail fix
- Volume boosters

MATERIALS

- Body materials and pressure ratings
- Trim
- Packing
- Guides and gaskets

QUALITY STANDARDS

- ASME
- NACE
- ISO 9000/2000
- PED
- NAMUR

INSTALLATION / MAINTENANCE

- Installation
- Commissioning
- Routine maintenance
- Fault finding
- Modes of failure

SUMMARY, OPEN FORUM AND CLOSING

Pre-Requisites

No specialist knowledge or skills are required - only a technical background so that there is an understanding for such factors as the difference between pressure and force. These topics are a good introduction to control valves as well as an important refresher course for control valve specialists who benefit from the back-to-basics approach.
Module 3: Practical Fundamentals of Chemical Engineering (for Non-Chemical Engineers)

You will Learn How to:

- Understand the fundamentals of chemical engineering
- Perform simple process calculations
-Troubleshoot process equipment and provide simple fixes
- Contribute to process design activities
- Do simple specifications of pumps and heat exchangers
- Understand mass transfer phenomena including agitation scale-up
- Understand process drawings and link them to plant operation
- Apply safety guidelines to a process or chemical plant
- Understand basic chemical engineering jargon and terminology

Overview

These topics will cover the fundamental concepts of chemical engineering and provide you with a solid working knowledge associated with it. If you are a non-chemical engineer this course will enable you to confidently talk to and work effectively with chemical engineers and process equipment.

Many technical professionals today find themselves working with large scale chemical processes even though they don’t have formal training in chemical engineering. This program intends to fill these gaps and provide you with knowledge of chemical engineering fundamentals along with the ability to apply this knowledge. By the end you will be familiar with the fundamentals of chemical engineering, process design considerations and troubleshooting of process equipment.

Pre-Requisites

An elementary understanding of engineering concepts such as fluid flow, heat and mass transfer is useful; however a revision will be covered at the start.

THE PROGRAM

Topic 3.1

INTRODUCTION: THE CHEMICAL PROCESS
- Process Flow Diagrams (PFDs)
- Piping and Instrumentation Diagrams (Pand IDs)
- Process legends used in flow sheets

STOICHIOMETRY
- Dimensions and units
- Processes and process variables
- Basic chemical calculations
- Material and energy balance
- Combustion

FLUID MECHANICS
- Fluid statics and its applications
- Basic equations and fluid flow
- Flow of compressible fluids
- Transportation and metering of fluids
- Agitation and mixing

HEAT TRANSFER AND ITS APPLICATIONS
- Heat transfer by conduction in solids
- Principles of heat flow in fluids
- Heat transfer to fluids
- Radiation heat transfer
- Heat-exchange applications
- Evaporation

MASS TRANSFER AND ITS APPLICATIONS
- Distillation
- Leaching and extraction
- Principles of diffusion
- Absorption
- Drying of solids

CHEMICAL ENGINEERING THERMODYNAMICS
- Fundamental quantities
- Thermodynamics
- Volumetric properties of pure fluids
- Heat effects
- Phase equilibria
- Chemical reaction equilibrium
- Conversion of heat into work by power cycles
- Refrigeration and liquefaction

Topic 3.2

CHEMICAL KINETICS
- Basic definitions
- Introduction to reactor design
- Design for single reactions
- Mixing of fluids
- Fluid particle reactions
- Solid-catalyst reactions

PROCESS EQUIPMENT DESIGN
- Storage vessels
- Pressure vessels
- Heat exchangers
- Evaporators and crystallisers
- Agitators
- Filters
- Dryers
- Process hazards and safety measures

PROCESS CONTROL AND INSTRUMENTATION
- Process instrumentation
  - Temperature
  - Pressure
  - Level
  - Flow
- Process control fundamentals
Module 4: Fundamentals of Process Plant Layout and Piping Design

You Will Learn How to:

- Understand plant layout fundamentals and procedures
- Apply fundamental principles of chemical process technology
- Use appropriate plant layout terminology and symbols
- Use process plant equipment
- Design piping systems and apply engineering principles
- Identify terminology, symbols and abbreviations in piping design
- Create and understand documents and drawings
- 3D modeling of plants and piping systems

Overview

Process plants such as refineries and petrochemical plants are complex facilities consisting of equipment, piping systems, instruments, electrical systems, electronics, computers, and control systems. The design, engineering and construction of process plants involves multidisciplinary team effort. Plant layout and design of piping systems constitute a major part of the design and engineering effort. The objective is to design safe and dependable processing facilities in a cost effective manner. The fact is that there are few formal training programs with a focus on plant layout and piping design, therefore most of the required skills are acquired while on the job, reducing productivity and efficiency.

These topics will cover the fundamental principles and concepts used in process plant layout and piping design. You will have an opportunity to learn and discuss the techniques and procedures used in the design and engineering of complex process plants, including fundamentals of plant layout, the equipment used, design principles and procedures. You will also understand fundamentals of piping system components and the specification and design of these components. Practical examples from actual projects will be used extensively to illustrate the principles and drive home the point. You will also be provided with high quality technical materials that will prove useful for many years.

THE PROGRAM

Topic 4.1

INTRODUCTION TO PROCESS PLANT LAYOUT AND PIPING DESIGN
- Plant layout fundamentals
- Procedures and workflow methods
- Physical quantities and units

INTRODUCTION TO CHEMICAL PROCESSING METHODS
- Basic principles of chemical technology - unit operations and unit processes
- Process Flow Diagrams (PFDs), process variables and stream information
- Process utilities

PROCESS AND INSTRUMENTATION DIAGRAMS (P&IDs)
- Fundamentals of P&IDs
- Use of P&IDs in plant and piping design
- Instruments and instrument symbols
- Components of control valve manifolds
- Meter runs for flow meters

Topic 4.2

EQUIPMENT USED IN PROCESS PLANTS
- Process equipment - reactors, towers, exchangers and vessels
- Mechanical equipment - pumps, compressors and turbines
- Equipment drawings, nozzle specifications and vendor drawings
- Equipment foundations and supports

PLANT AND PIPING DESIGN DOCUMENTATION AND TOOLS
- Equipment arrangement drawings
- Equipment lists
- Piping and Instrumentation Diagrams (P&IDs)
- Piping line lists
- Piping specifications and codes
- Piping isometrics
- Bill of materials
- 3D models

PLANT LAYOUT AND PLOT PLANS
- Plant layout specifications
- Guidelines and codes for plant layout
- Safety considerations
- Plot plans
- Equipment arrangement drawings

Topic 4.3

FUNDAMENTALS OF PIPE
- Piping materials
- Pipe dimensions and pipe data
- Pipe joining methods
- Pipe representation
- Common abbreviations

PIPING SYSTEM COMPONENTS
- Fittings - elbows, tees, reducers and end caps
- Fitting makeup and dimensions
- Flanges and flange ratings
- Valves, instrumentation, instrument connections and drains
- Pipe racks, pipe supports, anchors and guides

PIPE ROUTING
- Piping isometrics
- Piping plans, sections and elevations
- 3D representation

You Will Learn How to:

- Understand plant layout fundamentals and procedures
- Apply fundamental principles of chemical process technology
- Use appropriate plant layout terminology and symbols
- Use process plant equipment
- Design piping systems and apply engineering principles
- Identify terminology, symbols and abbreviations in piping design
- Create and understand documents and drawings
- 3D modeling of plants and piping systems
Module 5: Practical Process Control for Engineers and Technicians

You Will Learn How to:

- Understand and apply the fundamentals of process control and the latest techniques
- Tune PID control loops
- Connect cascade loops
- Understand cascade loops and feedforward control
- Correct long dead-times in a loop
- Specify and design the analog loop requirements for a plant using PID control
- Identify and apply the essential building blocks in automatic control
- Tune control loops with significant dead-times
- Demonstrate a clear understanding of analog process control and tune analog loops
- Explain concepts used by major manufacturers using current technology in the process control field

Overview

These topics cover all the essentials of process control and tools to optimise the operation of your plant and process, including the ability to perform effective loop tuning. Practical process control is aimed at engineers and technicians who wish to have a clear understanding of the essentials of process control and loop tuning, as well as how to optimise the operation of their particular plants or processes. Mathematical theory has been kept to a minimum with the emphasis throughout on practical applications and useful information.

Practical Sessions

You will perform hands-on, practical exercises using professional simulation software which is yours to keep.
Module 6: Practical Tuning of Industrial Control Loops for Engineers and Technicians

You Will Learn How to:

- Tune loops effectively and apply fundamentals of tuning loops
- Apply open and closed loop tuning rules effectively
- Get the best PID settings right first time
- Troubleshoot to achieve optimally tuned control loops
- Apply step-by-step descriptions of the best field-proven tuning procedures
- Apply typical procedures for troubleshooting tuning problems
- Tune more control loops in less time with consistently excellent results
- Understand the practical rules of thumb for tuning systems
- Be proficient at tuning with a detailed knowledge of
  - Open Loop Tuning
  - Closed Loop Tuning (including such classics as Ziegler Nichols Tuning and Lambda Tuning)
- Determine the minimum settling time for a control loop
- Gauge the optimum amount of filtering or dampening to apply to the measurement
- Handle problems such as valve hysteresis, stiction and non linearities
- Tune complex loops ranging from cascade to feedforward
- Use derivative control for the best tuned loop

Overview

This section is designed to train you in the latest procedures for the tuning of Industrial Control Loops using a minimum of mathematics and formulas. Loop Tuning refers to the complex skill of adjusting PID controller parameters so that the control loop performs satisfactorily under all the operational conditions it is expected to cope with. This skill cannot be acquired by merely reading books or manuals, it requires practice and practical experience and this course will provide you with the solid fundamentals in this area. You will gain the skills required to tune a controller for optimum operation.

An optimally tuned process loop is critical for a wide variety of industries ranging from food processing, chemical manufacturing, oil refineries, pulp and paper mills, mines and steel mills. Although tuning rules are designed to give reasonably tight control, this may not always be the objective. Some thought needs to be given when retuning a loop as to whether the additional effort is justified as there may be other causes of the poor control. These issues will be discussed in some detail. By the end of these topics you will have the skills to troubleshoot and tune a wide variety of process loops.

THE PROGRAM

Topic 6.1

FUNDAMENTALS OF TUNING LOOPS
- Processes, controllers and tuning
- PID controllers - P, I and D modes of operation
- Load disturbances and offset
- Speed, stability and robustness
- Gain, dead time and time constants
- Process noise
- Feedback controllers
- How to select feedback controller modes

Practical Session

FUNDAMENTALS OF TUNING
- Open loop characterisation of process dynamics
- Default and typical settings
- General purpose closed loop tuning method
- Quick and easy open loop method
- Fine tuning for different process types
- Simplified lambda tuning

Practical Session

Topic 6.2

THE DIFFERENT TUNING RULES
- Ten different rules compared
- Tables of typical tuning settings
- When to use them/when not to use them
- 28 rules of thumb in tuning

Practical Session

TUNING OF VALVES
- Hysteresis
- Stiction

Practical Session

Topic 6.3

AUTOMATED TUNING
- Self tuning loops
- Adaptive control

Practical Session

TUNING OF MORE COMPLEX SYSTEMS
- Cascade systems - tuning of them
- Feedforward, ratio, multivariable systems
- Interactive loops tuning
- Dead time compensation
- Practical limitations

Practical Session

GOOD PRACTICE
- Good practice for common loop problems
- Flow control loop characteristics
- Level control loop characteristics
- Temperature control loop characteristics
- Pressure control loop characteristics
- Other less common loops

Practical Session

Practical Sessions

Throughout this module, simulation software is used to simulate real loops and to give you EIGHT real hands-on exercises in a safe practice environment. You will see the simulated process output respond to your input and configuration changes on the loop controller. You will reinforce and apply the concepts learnt using simulation exercises that are close to the real world of the plant.
You Will Learn How to:

- Understand the architecture and operation of Distributed Control Systems (DCSs)
- Design the overall DCS and process control system
- Specify planned DCSs
- Improve process performance for your plant
- Understand the key ergonomic issues in design of operator displays
- Apply advanced control strategies to your plant control system
- Use your existing DCS process control capabilities more effectively
- Design and create a consistent and effective alarm philosophy for your installation
- Recognise and deal with human problems in interfacing to alarm systems

Overview

This module will cover the practical application advantages of the modern distributed control system (DCS) and how to maximise your return on this significant investment in both hardware and software. This includes the monitoring of the effectiveness and return on the on-line process and control system performance including due diligence on system alarm management. A variety of causes and cures for how these situations occur and can be corrected will be addressed as part of the course curriculum.

Most of the process control functionality that should be in a DCS can be configured in terms of well tried and virtually standard combinations of function blocks. All DCSs have a comprehensive library of these function blocks but few operations outside the hydrocarbon industries implement the control schemes required for reasonably comprehensive process stabilisation ("straight lines on screens") and constraint compliance ("operating hard up against the limits") capabilities on which control systems are justified.

This module will provide you with the tools to realise how to effectively use an integrated distributed control system and consequently optimise your process and profitability.
Module 8: Practical Programmable Logic Controllers (PLCs) for Automation and Process Control

You Will Learn How to:

- Understand fundamentals of PLC hardware and software
- Write a simple PLC program
- Troubleshoot a PLC system
- Engineer a complete PLC system
- Apply the essentials of IEC 61131-3

Overview

These topics are designed to benefit you with practical up-to-date information on the application of PLCs to the automation and process control of plants and factories. They are suitable for people who have little or no exposure to PLCs, but expect to become involved in some or all aspects of PLC installation. You will receive practical advice from experts in the field, to assist you to correctly plan, program and install a PLC with a shorter learning curve and more confidence. While the program is ideal for electricians, technicians and engineers who are new to PLCs, much of the content will be of value to those who already have some basic skills, but need a wider perspective for larger and more challenging tasks ahead. The accompanying material includes contributions from a number of experts and will become a valuable reference document in your work.

The information contained advances from the basics to challenge even the most experienced engineer in the industry today.

Practical Sessions

You will undertake a series of practical sessions, ranging from elementary to advanced, based on the PLCs supplied. Full working solutions will be distributed to you after you have attempted the practicals.

The practicals include:

- Write simple ladderlogic programs
- Creation and use of a single scan ‘pulse’
- Developing a simple program:
  - Valve limit switch monitoring
  - Pushbutton steps around a loop
  - Simple timers (a ‘reticulation’ timer)
  - Sequential startup
- Multiple recipe batch selection
- PID control loop

The Program

Topic 8.1

INTRODUCTION

- Introduction and brief history of PLCs and alternative control systems
- Why PLCs have become so widely accepted
- Lingering concerns about PLCs

FUNDAMENTALS OF PLC HARDWARE

- Block diagram of typical PLC
- PLC processor module - memory organisation
- Input and output section - module types

FUNDAMENTALS OF PLC SOFTWARE

- Methods of representing Logic, Boolean Algebra, instruction code and graphical presentation
- Fundamental ladder logic instruction set
- Comparison of different manufacturers, memory and data representation and instruction code

USING LADDER LOGIC FOR SIMPLE DIGITAL FUNCTIONS

- The basic rules
- Comparison of relay ladder diagrams
- The concept of the ‘scan’ and how to apply it
- Contact ‘normal’ states
- Positive and negative logic
- Basic Boolean functions

USING REGISTERS (WORDS)

- Number systems
- Types of register data
- Timers and counters
- Bit shift and rotate
- Table functions
- Register [Matrix] logic functions

Topic 8.2

GOOD PROGRAMMING HABITS

- Keeping track of addresses and data used
- Looking ahead - how will programs be maintained?
- Practical methods to improve quality: organisation of code, thorough documentation and simplifying changes

GOOD INSTALLATION PRACTICE

- Location of hardware
- Good wiring practice
- Cable spacing, power distribution and wire numbering
- Reducing noise and interference

ADVANCED CONTROL WITH PLCs

- The concept of reusable logic
- Examples, drive logic and alarm handling

Topic 8.3

DATA COMMUNICATIONS

- Interface standards, RS-232, RS-422/423 and RS-485
- Protocols, Modbus and DH+
- Local area networks, Ethernet and token bus
- Monitoring communication links and simple watchdog timers

INTRODUCTION TO IEC 61131-3

- Concepts
- Common elements
- Programming languages: structured text
- Function block diagrams
- Ladder diagrams
- Instruction list
- Sequential function chart

OPC

- Introduction to OPC
- Architecture

SYSTEM CHECKOUT AND TESTING

- Development and verification of code
- Factory acceptance testing
- Testing procedures
- Emulating missing hardware
- Emulating process responses
Module 9: Practical SCADA Systems for Industry

You Will Learn How to:
- The fundamentals of SCADA systems
- The essentials of SCADA software configuration
- Tricks and tips in installation of SCADA systems
- The essentials of SCADA telecommunications links
- The use of Industrial Ethernet in SCADA systems
- OPC and SCADA systems
- SCADA network security issues
- How to troubleshoot SCADA systems

Overview

SCADA has traditionally meant a window into the process of a plant or gathering of data from devices in the field, but now the focus is on integrating this process data into the actual business and using it in real time. The current emphasis is on using open communication protocols, such as IEC 60870, DNP3 and TCP/IP, and commercial off-the-shelf (COTS) hardware and software to keep the costs down.

This module covers the fundamentals of SCADA design, installation and troubleshooting. It presents an excellent opportunity to network with your peers as well as gain significant new information and techniques for your next SCADA project.

THE PROGRAM

Topic 9.1
BACKGROUND TO SCADA
- Fundamentals and definition of terms
- Comparison of SCADA, DCS, PLC and Smart Instruments
- Typical SCADA installations

SCADA SYSTEMS HARDWARE
- Remote Terminal Unit (RTU) structure
- Analog and digital input/output modules
- Application programs
- Point-to-point and point-to-multipoint systems
- System reliability and availability
- Configuration of a master station

SCADA SYSTEMS SOFTWARE
- Design of SCADA software packages
- Configuration of SCADA systems
- Connecting to PLCs and other hardware
- SCADA system design
- The Twelve Golden Rules

HUMAN MACHINE INTERFACES (HMIs)
- Human and ergonomic factors
- HMI configuration
- Design and layout
- Alarming and reporting philosophies
- Alarm system design

GOOD INSTALLATION PRACTICE
- Recommended installation practice
- Ergonomic considerations

LANDLINE MEDIA
- Noise and interference on cables
- Twisted pair cables and fibre optic cables
- Public network services

WIDE AREA NETWORK (WAN) TECHNOLOGIES
- Digital hierarchies, T1 and E1
- Packet switching
- Frame Relay
- ATM
- SDH/Sonet

LOCAL AREA NETWORKS (LANs)
- Industrial Ethernet
- TCP/IP
- Bridges, routers and switches
- Redundancy options
- Wireless
- OPC

INDUSTRIAL COMMUNICATIONS PROTOCOLS
- RS-232
- RS-485
- Modbus
- DNP3.0

MODEMS
- Introduction and principles
- Modulation techniques
- Error detection and correction
- Troubleshooting

Topic 9.3

SCADA NETWORK SECURITY
- Authentication and encryption
- Firewalls

TROUBLESHOOTING AND MAINTENANCE
- Troubleshooting SCADA systems
- Maintenance tasks

SPECIFICATION OF SYSTEMS
- Common pitfalls
- Standards
- Performance criteria
- Testing
- Documentation

PROJECT MANAGEMENT OF SCADA SYSTEMS
- Phases of a SCADA project
- Specification of systems
- Implementation and commissioning
Module 10: Practical Advanced Process Control for Engineers and Technicians

You Will Learn How to:
- Understand the essentials of Advanced Process Control (APC)
- Grasp the key differences between the various technologies
- Perform simple APC design strategies and implementations
- Be able to perform PID control
- Troubleshoot simple APC problems
- Identify processes suited to APC

Overview

In today’s environment, the processing, refining and petrochemical business is becoming more and more competitive and every plant manager is looking for the best quality products at minimum operating and investment costs. The traditional PID loop is used frequently for much of the process control requirements of a typical plant. However there are many drawbacks in using these, including excessive dead time which can make the PID loop very difficult (or indeed impossible) to apply. Advanced Process Control (APC) is thus essential today in the modern plant. Small differences in process parameters can have large effects on profitability; get it right and profits continue to grow; get it wrong and there are major losses. Many applications of APC have pay back times well within a year.

APC does require a detailed knowledge of the plant to design a working system. Considerable attention needs to be given to the operators to ensure that they can apply these new technologies effectively.

THE PROGRAM

Topic 10.1
JUSTIFICATION OF ADVANCED CONTROL
- Advanced vs. classical control
- Advanced on-line control vs. statistical process control
- Comparison of pay back time on real examples

Practical Exercise

FUNDAMENTALS OF PROCESS CONTROL
- Processes, controllers and tuning
- PID Controllers - P, I and D modes of operation
- Load disturbances and offset
- Speed, stability and robustness
- Gain, dead time and time constants
- Process noise and feedback controllers

Practical Exercise

FUNDAMENTALS OF TUNING PID LOOPS
- Open and closed loop tuning
- Ziegler Nichols
- Fine tuning for different process types
- Lambda tuning
- Ten different rules compared
- Cascade systems
- Feedforward control and deadline
- Models and disturbances

Practical Exercise

Practical Exercise

Topic 10.2
INTERNAL MODEL CONTROL (IMC)
- Open loop model in parallel with the process
- Control system in two blocks
- Equivalence with a classical controller
- Disturbances rejection and control
- IMC and delays and feed forward

Practical Exercise

MODEL PREDICTIVE CONTROL (MPC)
- Single input / output vs. multivariable control
- Example on a binary column Causality graph
- Constraints and planning ahead
- Different models

Practical Exercise

MPC : OBSERVERS
- Overall formulation and purpose
- Study of Kalman algorithm

Practical Exercise

MPC : CONTROL
- Overall formulation
- Hard constraints on manipulated variables
- Set values and soft constraints on control variables
- The notion of Horizon

Practical Exercise

Topic 10.3
REFERENCE MODELS
- Handling setpoints on controlled variables
- Measured and unmeasured disturbances rejection
- Handling soft constraints on controlled variables
- Rejection of disturbances

Practical Exercise

CONTROL FORMULATION PROBLEM
- Quadratic criterion vs. geometric control
- Importance of the horizon length
- Use of the weight matrix
- Handling output constraints along the horizon
- Projection of measured and unmeasured disturbances along the horizon
- Final quadratic problem formulation and resolution
- Off-line pre-processing
- On-line calculations

Practical Exercise

MPC STEADY STATE OPTIMISATION
- Degrees of freedom and rationale for optimisation
- Economic output submitted to setpoint
- Slogans to maximise or minimise
- Bridge from optimisation to control
- Reachable targets for economic variables
- Interpretation of the horizon for economic variables
- Change of the control formulation problem

Practical Exercise

APPLICATION OF THE THEORY TO THE CONTROL OF TWO DIFFERENT UNITS ON A PROCESS SIMULATOR
- Complete application (identification, controller design, control and optimisation)

Practical Exercise
Module 11: Practical Boiler Control and Instrumentation for Engineers and Technicians

You Will Learn How to:

- Understand the objectives of the principal boiler control functions
- Recognise and understand typical boiler control diagrams and their design intentions
- Contribute to the setting up and tuning of boiler control loops
- Design effective:
  - Boiler feed water control
  - Furnace draft measurement and control
  - Steam demand and firing rate control
  - Main steam and reheat steam temperature control
  - Flue gas analysis and fuel combustion trimming controls
- Recognise the importance of boiler safety control and start-up interlocks
- Explore advanced control strategies for improved boiler plant efficiency

Overview

You will gain knowledge on two subjects that are essential for anyone involved in using or applying controls to boilers. These are a basic knowledge of boiler and combustion processes and a basic knowledge of those control and instrumentation practices relevant to most boiler plant applications. The control training includes a review of the SAMA and ISA symbol standards used for depicting control system details. The training then proceeds in a series of topics to describe the basic requirements and typical control solutions for the main control and safety functions in boilers. These functions are structured into individual topics allocated to feedwater supply and drum level, furnace air and the control of draft pressure, combustion controls, steam pressure and temperature controls. The combustion control module addresses the issues of dynamic response of the fuel and air feeds with examples of how ratio control, feedforward signals and cross limiting methods are applied to ensure good load following.

The program includes a study of the basic principles of burner management systems and includes the measures used to support furnace safety through the enforcement of start up procedures and purge sequences. The requirements for burner management systems to be engineered as safety instrumented systems to IEC 61511 are examined and the implications for equipment design are discussed. The topics are supported by a series of practical study exercises with answers provided to assist the understanding of key issues.

Introduction

These topics introduce the basic practices of controls systems and safety controls for industrial steam generating boilers. The focus is on the control and safety requirements applicable to most types of boilers from small gas-fired units to large multi-fuel installations. This module will provide you with training in how control and instrumentation is designed to manage the main variables such as drum water level, furnace draft, combustion fuel and air conditions. Burner management systems are introduced with their principal features including flame safety systems. The essential safety requirements for boilers and burners are identified and the corresponding safety interlocks are explained as practical solutions in accordance with the latest safety standards.

Practical Sessions

There are practical exercises and assignment sessions to give you the confidence and experience to work on the installation, operation and maintenance of boiler plants.

Pre-Requisites

Fundamental knowledge of basic boiler plant and operation thereof and some understanding of control systems.

THE PROGRAM

**Topic 11.1**

**ESSENTIAL OF BOILER PROCESSES AND THEIR CONTROL FUNCTIONS**

- Objectives of boiler controls
- Boiler processes in block diagrams to show key inputs and output variables
- Hazards of boiler operations
- The main control functions in boilers and furnaces
- Furnace air and draft controls

**Topic 11.2**

**PRINCIPLES OF THE MAIN CONTROL FUNCTIONS**

- Principles of drum level measurement
- Principles of drum level controls and protection systems
- Principles of combustion controls
- Master pressure controls for multiple units
- Basic steam temperature control
- Essential of burner management systems
Module 12: Practical Hazardous Areas for Engineers and Technicians

You Will Learn How to:

- Demonstrate a basic understanding of the hazards associated with electricity near flammable gases and vapours
- Correctly approach design and installation of explosion protected apparatus safely in hazardous areas
- Understand the terminology used with Hazardous Areas
- Classify hazardous areas
- Detail the types of apparatus that can be used in a given hazardous area
- Explain the types of equipment that can be used in hazardous areas
- Understand safety and operational aspects of hazardous areas
- Understand system limitations in using hazardous areas protection
- Detail the key areas of the national codes of practice

Overview

This module will provide you with an understanding of the hazards involved in using electrical equipment in potentially explosive atmospheres. It is based on the international IEC79 Series of Standards. Explosion-protected installations can be expensive to design, install and operate. The wider approaches described in these standards can significantly reduce costs whilst maintaining plant safety. The module will explain the associated terminology and its correct use. It covers area classification through to the selection of explosion-protected electrical apparatus, describing how protection is achieved and maintained in line with these international requirements. Standards require that engineering staff and their management are trained effectively and safely in Hazardous Areas and these modules are designed to help you fulfil that need.

Pre-Requisites

You will require a basic understanding of instrumentation and electrical theory for this section to be of greatest benefit. No previous knowledge of hazardous area installation is required.

THE PROGRAM

Topic 12.1
HAZARDOUS AREAS
- Introduction: explosion consequences
- Risk assessment
- Properties of flammable materials
- Definitions
- Classification system: sources of release and zoning
- Classification of apparatus: grouping and temperature

Topic 12.2
STANDARDS
- British standards
- European
- North American
- International

CERTIFICATION and APPROVALS
- Marking and identification
- Notified bodies
- Authorities
- IEx, EEx and AEx schemes
- ATEX directives in Europe
- Principles of Ex protection
- Component, apparatus and systems certification

Topic 12.3
PROTECTION
- Theory and definitions
- Practical aspects and limitations of use
- Flameproof Ex d
- Increased Safety Ex e
- Non-Incendive Ex n
- Pressurisation Ex p
- Oil-Immersion Ex o
- Sand-filling Ex q
- Encapsulation Ex m
- Intrinsic Safety Ex i
- Special Ex s

Topic 12.4
INSTALLATION
- General requirements for all types of protection
- Selected specific requirements
- Earthing and bonding
- Operation and maintenance of apparatus

INSPECTION AND MAINTENANCE
- Requirements
- Visual close and detailed types
- Use of tools and test equipment
- What to look out for
You Will Learn How to:

- Determine required SIL ratings using at least 3 different methods as listed in IEC 61511
- Assess your plant’s compliance with the latest international safety standards
- Understand the fundamentals of IEC 61511 and IEC 61508 which you can apply immediately to your plant
- Help your company to comply with the best available practices for their safety control systems
- Get a practical understanding of the key sections of IEC 61511 and 61508 without wading through hundreds of pages of standards documents
- Configure safety systems to minimise or avoid spurious trips and create the potential to reduce production losses.
- Know what can be done and what should not be done with PLCs and smart sensors

* The IEC 61511 standard is effectively the operating company’s guide to the management, planning and execution of state of the art risk reduction measures using instrumentation and control equipment. IEC 61511 effectively merges the established USA standard ANSI/ISA S 84 - 1996 with the European practices founded in IEC 61508.

Overview

For project managers and engineers involved with hazardous processes, this module of the course focuses on the management, planning and execution of automatic safety systems in accordance with IEC 61511, the newly released international standard for process industry safety controls. IEC 61511 has been recognized by European safety authorities and by USA based process companies as representing the best practices available for the provision of automatic safety systems. The content is structured into two major parts to ensure that both managers and engineering staff are trained in the fundamentals of safety system practices.

Practical Sessions

There are at least five practical exercise sessions to give you the hands-on experience you will need to:
- test your understanding of risk reduction principles
- apply fault tree analysis methods to evaluate risk levels, specify safety performance requirements, determine SIL targets, decide on system architectures and perform reliability evaluations.

**THE PROGRAM**

**Topic 13.1**

**AN OVERVIEW OF SAFETY INSTRUMENTED SYSTEMS FOR MANAGERS**

- The principles of safety-instrumented systems including the concepts of risk reduction, safety integrity levels and the essential design and performance requirements of safety control systems.
- The scope and application of the IEC standards 61508 and 61511 and their principal requirements.
- Essential features of safety PLCs
- The safety life cycle

**Topic 13.2**

**SAFETY REQUIREMENTS SPECIFICATION**

- How hazard analysis and risk assessment leads to the safety requirements specification
- Demand mode and continuous mode methods for risk reduction
- LOPA and Risk graph methods for determination of SIL targets
- Fault tolerance and redundant architectures

**Topic 13.3**

**SAFETY SYSTEM EQUIPMENT SELECTION AND APPLICATION SOFTWARE**

- Essential features of field devices
- Instrument selection and issues of certification
- Safety PLCs and networks
- Application software activities and tools

**Topic 13.4**

**PERFORMANCE EVALUATION, TESTING AND MAINTENANCE OF SAFETY SYSTEMS**

- Basic reliability analysis and how it benefits the end user
- Diagnostics and proof testing for improved performance
- The benefits of safety certified and smart instruments
Module 14: Practical HAZOPS* for Engineers and Technicians

*Hazard and Operability Studies

You Will Learn How to:

- Implement HAZOP as part of risk and safety management
- Identify strengths and weaknesses of the HAZOP approach
- Select optimum teams and gain information
- Use HAZOP procedure and explain it to the team at the first meeting
- Format workshop records and make recommendations and rank risks
- Be an effective leader
- Work with the HAZOP team secretary
- Determine cost effectiveness of remedial measures
- Identify types of HAZOP and alternatives to a HAZOP
- Use popular HAZOP software packages
- Follow-up action files and closeout of actions

Overview

This module will concentrate on awareness level training for managers, engineers and technicians in the practical application of hazard and operability workshops [known as HAZOP]. Training takes the form of an introductory presentation followed by interactive examples where you can obtain an understanding of the HAZOP technique and HAZOP team leaders can practice the required skills. HAZOP is widely used for identifying hazards in an industrial process and for assessing the potential consequences where there are risks of harm to persons, the environment or to assets.

The HAZOP technique is fully recognised and recommended throughout industry by professional engineering institutions, government regulators and insurance companies. It is one of the principle risk management tools required by most government regulators for industrial processes worldwide. HAZOP is applied at both the design stage and throughout the life of a process plant, where it supports the safety management and [where applicable] the validation of the plant safety case. HAZOP is also an essential technique when reviewing modifications and upgrades to existing plants.

This will introduce you to the basics of the HAZOP technique and discuss its relationship with other safety [risk] management tools. HAZOP can be applied to any process industry, onshore or offshore, be it in the oil and gas industry, mining, chemical or other processing industries. Consequently it will be of interest to a variety of managers and to most engineering disciplines. Examples include the design of a new process plant and modifications to an existing process plant. The study of process flow-sheets and process and instrumentation diagrams (P&IDs) will also be covered.

SCOPE

These topics will provide training in the techniques of hazard and operability studies that are widely used in industry for the identification of potential hazards in process plant operations. HAZOP can be adapted to a wide range of applications to seek out operational failure modes and possible harm to persons, environment or assets. HAZOP methods have been extended to searching for hazards in operational procedures in many other fields including electronic controls and emergency planning procedures.

This module will describe the role of HAZOP within a framework of risk management techniques that support the field of Process Hazard Analysis. The training will cover the 4 phases of Hazop activities, which comprise: Planning, preparation, examination and reporting with particular emphasis on the details of the examination phase in which guidewords are systematically applied to parts of a process or stages of an operation to test for deviations from design intent. A number of practical exercises support the training information and allow you to test your understanding of the material provided in the training manual. The content extends to include risk assessment techniques such as FTA and determination of safety integrity levels (SILs) for safeguarding using safety instrumented systems.

HAZOP studies interact closely with process design and safety engineering solutions in the critical stages of engineering projects. Understanding these interactions will assist to plan your work efficiently and to contribute effectively to the reduction of risks in the workplace. You will learn how information flow from HAZOP supports safety management throughout the life cycle of the plant. The HAZOP techniques and safety system practices described are based on the latest international practices including the guidelines in IEC 61822 for HAZOP studies.

Practical Sessions

There are at least five practical exercise sessions to give you the hands-on experience you will need to develop your skills in applying HAZOP method to some basic process plant examples in continuous and batch processes.

THE PROGRAM

Topic 14.1

INTRODUCTION TO THE PRINCIPLES OF HAZOP
- The how, when and why outline of Hazard and Operability Studies (HAZOPS)
- Hazard studies and regulations
- The six level life cycle model
- Typical HAZOP workshop

Topic 14.2

THE HAZOP EXAMINATION PHASE
- Defining the parts for study
- Generating deviations with guidewords
- Worked examples of process HAZOP for continuous plant
- Procedural Hazop for sequential operations and batch processes

Topic 14.3

PLANNING AND LEADERSHIP OF HAZOP WORKSHOPS
- Duties of the team leader
- Make up of the study team
- Leading the sessions
- Recording and reporting methods

Topic 14.4

FROM HAZOP TO HAZARD ANALYSIS AND SILS
- Fundamentals of risk assessment and the risk matrix
- Risk reduction and layers of protection
- The role of safety instrumented systems and determination of SIL targets
- Hazard analysis methods of FMEA, FTA and LOPA
Module 15: Practical Shielding, EMC/EMI, Noise Reduction, Earthing and Circuit Board Layout of Electronic Systems

You Will Learn How to:

- Identify, design correctly and fix EMC/EMI problems
- Know why and how to earth a circuit effectively
- Efficiently diagnose noise problems
- Effectively design to filter at MHz frequencies
- Minimise the four noise coupling mechanisms
- Understand the function of the signal earth versus the signal return
- Earth a cable shield correctly
- Reduce DC power bus noise
- Select cables appropriately
- Know when to shield and when to filter
- Effectively earth mixed analog and digital signals
- Minimise pulse ringing and rounding problems
- Reduce earth loop noise
- Reduce emission and susceptibility problems
- Create a check list of items to ensure CE Approval

Overview

The aim of this module is to help you identify, design, prevent and fix common EMI/EMC problems with a focus on earthing and shielding techniques. Learning how to fix earthing and shielding problems on the job can be very expensive and frustrating. Although it must be noted that most of the principles involved are simple, these topics will give you the tools to approach earthing and shielding issues in a logical and systematic way. The circuit board layout section concentrates on design and layout of circuits and components on a printed circuit board. The overall focus is on useful design and systems issues; not about regulations and standards. You will take this material back with you to your work and apply the key principles immediately to your design and troubleshooting challenges.

Pre-Requisites

Some working knowledge of basic electrical engineering principles is required, although there will be a revision at the beginning of the workshop. No prior EMC or electrical noise knowledge is necessary.
You Will Learn How to:

- Understand best practice in industrial data communications design, installation and commissioning
- Design and install your own fully operational industrial data communications systems
- Integrate different industrial communications protocols and standards into a complete working system

Overview

These topics will outline best practice in designing, installing, commissioning and troubleshooting industrial data communications systems. In any given plant, factory or installation there are a myriad of different industrial communications standards used and the key to successful implementation is the degree to which the entire system integrates and works together. With so many different standards on the market today, the debate is not about what is the best - be it Foundation Fieldbus, Profibus, Devicenet or Industrial Ethernet but rather about selecting the most appropriate technologies and standards for a given application and then ensuring that best practice is followed in designing, installing and commissioning the data communications links to ensure they run fault-free. The industrial data communications systems in your plant underpin your entire operation. It is critical that you apply best practice in designing, installing and fixing any problems that may occur.

This module will distil all the tips and tricks and give the best proven practices to follow. The main steps in using today’s communications technologies involve selecting the correct technology and standards for your plant based on your requirements; doing the design of the overall system, installing the cabling and then commissioning the system. Fibre optic cabling is generally accepted as the best approach for physical communications but there are obviously areas where you will be forced to use copper wiring and indeed, wireless communications. These topics outline the critical rules followed in installing the data communications physical transport media, ensuring trouble free installation for years to come. The important point to make is that with today’s wide range of protocols available, you only need to know how to select, install and maintain them in the most cost effective manner for your plant or factory - knowledge of the minute details of the protocols is not necessary.

THE PROGRAM

Topic 16.1
CABLING INFRASTRUCTURE
- Noise, earthing and shielding
- Protection against dust and moisture
- Copper/fibre
- Cable and connector standards
- Splicing
- Connector attachment
- Drivers and detectors
- Grounding and termination
- Protection against transients

Topic 16.2
PHYSICAL LAYER STANDARDS
- RS-232
- RS-485
- 4-20 mA

Topic 16.3
INDUSTRIAL PROTOCOLS
- TCP/IP
- Modbus and Modbus TCP
- DNP3
- 60870 SCADA

Topic 16.4
INDUSTRIAL NETWORKS (1)
- Modbus Plus
- Data Highway Plus
- HART

Topic 16.5
INDUSTRIAL NETWORKS (2)
- DeviceNet
- Profibus
- Foundation Fieldbus

Topic 16.6
INDUSTRIAL NETWORKS (3)
- Ethernet/IP
- Profinet
- Foundation Fieldbus HSE

Practical Sessions

There are several practical exercises and assignment sessions to give you the confidence and experience to work with industrial data communications networks.
You Will Learn How to:

- Implement simple radio telemetry links for SCADA systems
- Understand the jargon, terminology and latest techniques
- Design and install an effective radio telemetry link
- Perform simple path loss calculations
- Troubleshoot radio telemetry communication problems
- Specify the main components of radio, satellite and microwave telemetry links
- Conduct a site survey
- Implement effective security on radio, wireless and Ethernet networks
- Explain the infrastructure requirements for effective systems
- Outline future trends in SCADA and telemetry systems

Overview

These topics have been designed in conjunction with radio telemetry experts from throughout the world (the SCADA list) and aim at providing you with all the critical information you will need. You will start with a review of radio and wireless fundamentals to ensure you are brought up to speed with the basics. The essentials of data communications (and Ethernet) are then reviewed as they apply to radio telemetry systems. A review of wireless LAN systems is undertaken with a comparison of radio modems, along with the fast growing topic of cellular radio data services. Protocols are a key part of all radio telemetry systems and we investigate the importance of them together with the challenges associated with radio. Satellite and microwave systems are given a brief overview, followed by performance analysis. A discussion on radio telemetry systems would not be complete without sketching out the key issues of SCADA systems and alarm management. The overall network architecture of radio telemetry systems is then detailed.

You will conclude with an examination of troubleshooting techniques and the vital topic of security and encryption. These topics reflect today’s emphasis on using open protocols and networking standards such as DNP3, TCP/IP and Ethernet off-the-shelf hardware and software to keep the costs down. You will gain real life skills with a selection of case studies, used to illustrate the key concepts with examples of real-world radio telemetry systems in water, electrical and processing industries. You will also have an excellent opportunity to network with your peers as well as to gain significant new information and techniques for your next radio telemetry project.
Module 18: Practical Wireless Ethernet and TCP/IP Networking

You Will Learn How to:

- Use current Wireless LAN (WLAN) technologies
- Apply WLANs to industrial automation
- Implement a simple WLAN for your office and industrial plant and interface it to Ethernet
- Assess strengths and weaknesses of the different WLAN technologies
- Operate IEEE 802.11 WLANs
- Implement effective security on Wireless and Ethernet LANs
- Conduct a site survey in preparation for WLAN implementation

Overview

The use of Wireless and Ethernet in industrial and plant floor environments has grown dramatically in the last few years. Industrial users face a wide range of options when designing and implementing plant-level Wireless and Ethernet networks. Great success is being achieved using Wireless, provided certain ground rules are applied. These topics cover IEEE 802.3 Ethernet LANs and IEEE 802.11 WLANs, as well as all the supporting technologies. These issues will be addressed in a clear and practical manner, enabling you to apply the technology quickly and effectively in your next project. By the end of this module you will have a clear understanding of the choices available to you in designing and implementing your own Wireless and associated Ethernet LANs.

Pre-Requisites

A basic working knowledge of data communications and applications is useful, but is not essential. The program starts at a very basic level and advances to a solid practical implementation level. However with the outstanding IDC documentation; everything is detailed in a simple-to-understand manner for future reference.
Module 19: **Motor Protection, Control and Maintenance Technologies**

**You Will Learn How to:**

- Specify protection requirements for motors
- Maintain electrical motors
- Specify speed control requirements for motors
- Understand essentials of motors and drives
- Detail the main issues with testing of motors
- Prevent or at least minimise motor bearing failure
- Troubleshoot and fix faults on motors and drives
- Interface control circuits of motors with PLCs/DCSs
- Reduce downtime on electrical motors
- Improve plant safety
- Improve plant throughput
- Reduce your spares usage and requirements

**Overview**

It is estimated that electrical drives and other rotating equipment consume about 50% of the total electrical energy consumed in the world today (and this figure increases to 70% if you only consider industry.) The cost of maintaining electrical motors can be a significant amount in the budget item of manufacturing and mining industries. This module will give you a thorough understanding of electrical motor’s protection, control and maintenance and provide you with the tools to maintain and troubleshoot electrical motors. You will gain a fundamental understanding of the protection, control and maintenance of electric motors and drives. Typical applications of electric motors in mining, manufacturing, materials handling and process control will be covered in detail. The concluding topic of the course will give you the fundamental tools in troubleshooting motors confidently and effectively.

**Pre-Requisites**

A fundamental knowledge of basic electrical concepts would be useful.
Module 20: Practical Power Distribution for Engineers and Technicians

You Will Learn How to:

- Understand practical power distribution fundamentals
- Correctly implement the right type of switchgear for the appropriate application
- Economically select and install the best-suited power cable for a specific application
- Evaluate the need for power factor correction, and successfully implement correction strategies
- Implement successful maintenance strategies and procedures
- Effectively use software techniques to solve problem areas in your power network
- Determine short-circuit ratings quickly and effectively
- Assess the influence of fault levels on switchgear ratings
- Evaluate the advantages of modern state-of-the-art switchgear protection for your applications, including preventative maintenance information
- Recognise the different applications for various cable insulation types
- Correctly utilise and protect power transformers
- Assess and specify correct earthing throughout your electrical network
- Assess the economic justification for installing PFC equipment
- Correctly specify PFC equipment and be aware of practical consequences
- Confidently use software to solve and predict simple power network problems

Overview

These topics will focus on medium voltage [1 kV - 36 kV] power considerations, switchgear, power cables, transformers, power factor correction, earthing/grounding, lightning protection and network studies. You will gain technical know-how in these areas not covered by university or college programs.

Practical Design Sessions

Throughout the module you will perform practical design calculations to reinforce your understanding of each section.

Practical Demonstration

These will include how to use computer simulation software to design and/or troubleshoot your electrical power network - important practical issues in doing fault level calculations, load flow forecasts, motor starting studies and equipment sizing.

THE PROGRAM

Topic 20.1

INTRODUCTION
- Definition of power distribution
- Elements of a power distribution network
- Focus of workshop

FUNDAMENTALS OF POWER DISTRIBUTION
- Overview of basic electrical theory
- Basic design considerations
- Voltage considerations and improvement of voltage conditions
- Equipment generally used in power networks today

SHORT-CIRCUIT CURRENT CALCULATIONS
- Sources of fault current
- Fundamentals of short-circuit current calculations
- Assumptions and simplified calculations
- Restraints of simplified calculations
- Worked examples

Topic 20.2

MEDIUM VOLTAGE SWITCHGEAR
- Load currents and fault currents
- Switchgear capabilities and ratings
- Types of switchgear manufactured today and their applications
- Comparison of different types of insulation methods [air, oil, vacuum, SF6]
- Advantages and disadvantages of different types of medium voltage switchgear
- Internal arc proofing
- Modern protection relays used with switchgear
- Preventative maintenance
- Future trends

POWER CABLES
- Insulation types and their applications
- Cable losses and voltage drop
- Cable ratings and short-circuits
- Single core vs three core cables
- Cable installation
- Cable splicing and termination techniques

Topic 20.3

TRANSFORMERS
- Classifications
- Specifications
- Power transformers
- Connections and voltage taps
- Transformer impedance
- Insulation methods
- Cooling techniques
- Star-point earthing
- Accessories and protection

COMPENSATION AND POWER FACTOR CORRECTION
- Various capacitive and reactive compensation methods
- Overview of power factor theory
- Causes and effects of low power factor
- Methods to improve power factor and benefits
- Caution: capacitors with induction motors
- Transients and capacitor switching
- Resonance and harmonics
- Protection of capacitor banks
- Economic justification for power factor correction

Topic 20.4

EARTHING
- System earthing
- Equipment earthing and earthing of structures
- Electrical safety earthing
- Static earthing
- Lightning protection
- Ground resistance measurement
- Factors influencing ground resistance

OVERVIEW OF COMPUTER SIMULATION SOFTWARE
- Load flow studies
- Fault level studies
- Equipment sizing
- Motor starting studies

LATEST DEVELOPMENTS IN TECHNOLOGY
- Automation of power distribution networks
- Digital instrument transformers
You Will Learn How to:

- Create quality project plans
- Generate effective work breakdown structures
- Create computerised PERT and GANTT charts for your projects, add and level resources and monitor/report on your project effectively
- Define appropriate cost reporting mechanisms for your projects
- Define, analyse and manage the risks associated with your projects
- Introduce appropriate Quality Management procedures
- Keep your projects on track using the Earned Value Analysis method
- Exercise an appropriate leadership style and keep team members creative and motivated
- Avoid the pitfalls caused by a lack of understanding of the legal issues pertaining to projects
- Use appropriate software to leverage your time and expertise
- Deal with projects that have a large degree of inherent uncertainty and/or a strong emphasis on timely completion

Overview

More and more engineering and technical professionals are making career transitions from product design into project management. This, however, requires formal training and a willingness to learn new skills. All the technical know-how in the world will not deliver a project successfully, i.e. with the required level of quality, within cost constraints and on time, without proper project management skills. Unfortunately very few engineering professionals have any degree of formal project management training, which results in a great deal of personal stress as well as cost blowouts and other woes, too often cited in the media. The lack of training often applies to the ‘people skills’ required for effectively leading the project team as well.

To address this problem, these topics will focus on the critical project related activities such as work breakdown, scheduling, cost control and risk management and show how these can be performed with software to lighten the project manager’s workload. The ‘soft’ [but equally important] aspects such as team leadership and contract law are also covered. All topics will be supplemented with practical exercises focussing primarily on the areas of electrical/electronic [including instrumentation] and mechanical engineering. If you wish to do so, you can choose [as a basis for the practical exercises], small projects from your work environment so that you are familiar with the attributes thereof.