



## The Diploma in Packaging

### Examination Syllabus

<b>1 MODULE 1</b>	<b>1</b>
<b>1.1 Packaging Theory and Materials</b>	<b>1</b>
1.1.1 Theory	1
1.1.2 Materials	1
<b>1.2 Beer Preparation</b>	<b>1</b>
1.2.1 Fundamentals of brewing practice	1
1.2.2 Beer filtration	2
1.2.3 Beer dilution, carbonation and bright beer handling	2
1.2.4 Theory and practice of sterile filtration and pasteurisation	2
<b>1.3 Planning and Line Design</b>	<b>2</b>
1.3.1 Capacity planning	2
1.3.2 Operational planning	3
1.3.3 Line design	3
<b>1.4 Small Pack Operations</b>	<b>3</b>
1.4.1 Fundamental considerations	3
1.4.2 Pre-filling operations	3

1.4.3 Theory and practice of filling technology	4
1.4.4 Container closing	4
1.4.5 Post-filling operations	4
1.4.6 Secondary packaging	4
<b>2 MODULE 2</b>	<b>5</b>
<b>2.1 Large Pack Operations</b>	<b>5</b>
2.1.1 Fundamental considerations	5
2.1.2 Pre-filling operations	5
2.1.3 Theory and practice of keg and cask filling	5
2.1.4 Post-filling operations	5
2.1.5 Draught beer dispense	5
<b>2.2 Brewing</b>	<b>6</b>
2.2.1 Sweet wort production	6
2.2.2 Wort boiling	6
2.2.3 Wort clarification, cooling and oxygenation	6
2.2.4 Fermentation and yeast management	6
2.2.5 Maturation, chilling and cold storage	7
<b>2.3 Carbonated Soft Drinks</b>	<b>7</b>
2.3.1 Introduction to soft drinks	7
2.3.2 Raw materials and drink preparation	7
2.3.3 Production operations	7
2.3.4 Dispense	8
2.3.5 Product developments and adaptations	8
<b>2.4 Quality</b>	<b>8</b>
2.4.1 Quality control	8
2.4.2 Laboratory analysis	8
2.4.3 Hygiene	8
2.4.4 Quality assurance	9
<b>2.5 Operations Management</b>	<b>9</b>
2.5.1 Line operations	9
2.5.2 World class manufacturing	9
2.5.3 Finance	10
2.5.4 Purchasing	10
<b>3 MODULE 3</b>	<b>11</b>
<b>3.1 Resource Management</b>	<b>11</b>
3.1.1 Environment	11
3.1.2 Health and safety	11
3.1.3 Utilities	11
3.1.4 Maintenance	11
<b>3.2 Fluid Mechanics</b>	<b>12</b>
3.2.1 Principles of fluid mechanics	12
3.2.2 Process gases	13
<b>3.3 Heat Transfer</b>	<b>13</b>
3.3.1 Principles of heat transfer	13
3.3.2 Steam	14
3.3.3 Refrigeration	14

<b>3.4 Process Control</b>	15
3.4.1 Process control	15
3.4.2 Instrumentation	15
<b>3.5 Materials of Construction</b>	15
3.5.1 Classification and properties	15
3.5.2 Applications and limitations	15

# 1 MODULE 1

## 1.1 Packaging Theory and Materials

### 1.1.1 Theory

- History and development of packaging
- Packaging principles

### 1.1.2 Materials

- Glass bottles
- advantages and disadvantages of glass
- bottle manufacturing
- bottle faults and testing
- Plastic bottles
- advantages and disadvantages
- principles of bottle manufacturing
- bottle faults and testing
- Emerging bottle formats
- Crowns and caps
- types of closure
- crown and cap manufacturing
- sealing
- Cans and ends
- advantages and disadvantages of cans
- can and end manufacturing
- shell and tab assembly
- inspection and palletization
- Paper and cardboard
- advantages and disadvantages of paper and cardboard
- principles of manufacturing
- different types of paper and cardboard
- Plastics
- plastic films and other polymers
- plastic crates
- Adhesives
- types of adhesives
- principles of adhesion
- Kegs and spears
- keg components
- keg manufacturing and materials
- types of spear and spear safety

## 1.2 Beer Preparation

### 1.2.1 Fundamentals of brewing practice

- Definition of beer and beer types
- Raw materials
- malt, adjuncts, water and hops
- Basic brewing process

- milling, mashing, conversion, separation, wort boiling, fermentation and beer maturation
- Key beer properties
- Basic principles of handling beer and maintaining its key properties

### **1.2.2 Beer filtration**

- Purposes and principles of filtration
- rough, polishing and stabilizing filtration
- different methods of filtration
- principles of filter design and operation
- the impacts of temperature, time, pressure and microbiological concentrations
- filtration safety considerations

### **1.2.3 Beer dilution, carbonation and bright beer handling**

- De-aerated liquor (water) and beer dilution
- use in high gravity brewing
- quality requirements for dilution liquor
- the production of de-aerated liquor
- blending procedures and calculations
- Purposes and principles of carbonation
- principles of gas solubility
- carbonation equipment
- Bright beer storage and release of beer for packaging
- Maintaining beer quality up to the filler
- design and procedural methods to control beer dilution
- variations in CO<sub>2</sub> levels, O<sub>2</sub> pick-up and loss of foam potential - microbiological and chemical contamination risks

### **1.2.4 Theory and practice of sterile filtration and pasteurisation**

- Sterile filtration theory, filter design and operation
- Definition of pasteurisation and pasteurisation unit
- definition and aims of pasteurization
- definition of pasteurization units (PU)
- effects of pasteurization on different microbiological organisms
- Design, operation and control of a flash pasteuriser
- principal effects on beer quality during pasteurization
- Design, operation and control of a tunnel pasteuriser
- measurement of PUs
- chemical treatment of pasteurizer water
- the principal effects on beer quality during pasteurization

## **1.3 Planning and Line Design**

### **1.3.1 Capacity planning**

- Forecasting demand
- market and category forecasting
- methods for forecasting demand

- consideration of restraints such as raw materials, labour, transport, utilities and maintenance
- Strategic and tactical planning
- the difference between the two and the key elements of strategic and tactical plans

### **1.3.2 Operational planning**

- Line planning and scheduling
- translating forecasts into plans and schedules
- measuring performance
- the role of shift patterns in planning and scheduling
- accommodating maintenance activities
- Planning and production constraints
- internal and external influences

### **1.3.3 Line design**

- Line design theory
- principles of line design
- design constraints
- the 'V' graph
- advantages and disadvantages of line layout formats
- conveyor design
- line design calculations
- Manning philosophy
- line layout
- manual and automatic operation
- operational requirements
- culture and skills
- Materials handling
- location of warehouses
- Just-in-Time (JIT) material deliveries
- Fork Lift Truck/automated guided vehicle handling
- storage conditions for materials and finished product -  
Waste handling

## **1.4 Small Pack Operations**

### **1.4.1 Fundamental considerations**

- Typical small pack line layouts showing schematic designs and flow diagrams
- Influence of container design and specification (on filling performance)
- container standardization and product differentiation
- the impact of container design on conveying and handling - bottle appearance and fill height control

### **1.4.2 Pre-filling operations**

- Container reception, depalletizing and returnable bottle handling
- Container preparation for filling
- crate washing

- bottle washing
- bottle and can rinsing

#### **1.4.3 Theory and practice of filling technology**

- Filling theory and principles
- the filling cycle
- types of fillers
- The design and operating principles of glass bottle fillers and the filling process
- The design and operating principles of PET bottle fillers and the filling process
- The design and operating principles of a can filler and the filling process
- The design and operating principles of a sterile/aseptic filler and the filling process
- Widget technology
- the purpose and development of widgets
- operating principles
- types of widget and associated technology

#### **1.4.4 Container closing**

- The design and operating principles of a bottle crowner and the crowning process
- The design and operating principles of a can seamer and the seaming process

#### **1.4.5 Post-filling operations**

- Drying containers
- the purpose of drying bottles and cans
- The design and operation principles of a bottle labeller and the labelling process
- Container sleeving and coding
- The design and operating principles of a palletizer and the palletizing process
- Warehousing, storage conditions and stock rotation

#### **1.4.6 Secondary packaging**

- The design and operating principles of a secondary packaging machine and the packaging process
- Types of secondary packaging

## MODULE 2

### 1.5 Large Pack Operations

#### 1.5.1 Fundamental considerations

- Role and importance of keg and cask beer
- Typical keg and cask line layouts
- schematic diagrams showing configuration of complete line with all key plant items and conveying
- simple flow diagrams showing key plant items and product flow

#### 1.5.2 Pre-filling operations

- Container collation methods
- De-unitizing
- External keg and cask washing and label removal
- Keg orientation and spear torque tightness

#### 1.5.3 Theory and practice of keg and cask filling

- Filling theory and principles
- specific issues for beer
- the cleaning cycle
- keg sterilization
- the filling cycle
- Design and operation of cleaning / filling machines
- lane cleaning/filling machine
- rotary cleaning/filling machines
- Gases as a top pressure

#### 1.5.4 Post-filling operations

- Labelling, coding and capping
- purpose of labels and caps
- design and operation of labelling machines
- design and operation of coding machines
- design and operation of capping machines
- Keg tracking
- purposes of keg tracking
- keg security
- systems for tracking
- Unitizing
- Warehousing
- storage conditions and stock rotation

#### 1.5.5 Draught beer dispense

- Design and operation of dispense equipment
- Hygiene
- Dissolved gas control
- Temperature control



## **1.6 Brewing**

### **1.6.1 Sweet wort production**

- Raw materials
- barley, malting and malt
- adjuncts
- water
- Milling operation
- mills
- grist
- safety
- Mashing and conversion
- process of conversion
- mashing systems
- Wort separation
- objectives of wort separation
- wort separation systems
- spent grain

### **1.6.2 Wort boiling**

- Purposes of boiling wort
- Kettle additions
- liquid adjuncts
- kettle finings
- Hops and hop bitterness
- hops and hop products
- Wort boiling systems
- kettles with internal and external heating elements
- typical control parameters

### **1.6.3 Wort clarification, cooling and oxygenation**

- Wort clarification
- composition of trub
- systems for wort clarification
- Wort cooling
- principles of operation of plate heat exchangers
- benefits of plate heat exchangers
- Wort oxygenation / aeration
- purpose of wort oxygenation
- advantages and disadvantages of hot and cold aeration

### **1.6.4 Fermentation and yeast management**

- Principles of fermentation
- types of yeast
- fermentation process
- Fermentation implications for beer flavour
- importance of fermentation by-products
- fermentation conditions and performance consistency

- Fermentation practice
- fermentation vessels for top and bottom cropping yeast
- fermentation control
- Yeast handling in the brewery
- yeast pitching, cropping and storage
- Yeast propagation
- yeast propagation principles
- methods of long-term culture storage

### **1.6.5 Maturation, chilling and cold storage**

- Maturation
- flavour maturation, clarification and stabilization
- Maturation practice
- maturation processes and equipment
- Additions to beer
- purpose and nature of beer additions

## **1.7 Carbonated Soft Drinks**

### **1.7.1 Introduction to soft drinks**

- History and background
- raw materials
- manufacturing processes
- quality control, safety and hazard prevention
- Soft drink specific packaging materials
- objectives of packaging
- packaging materials and types
- Line layouts
- differences with beer operations
- typical soft drink line layouts

### **1.7.2 Raw materials and drink preparation**

- Ingredients, additives and flavourings
- regulations
- sweeteners
- acidulants
- preservatives
- colouring
- Water preparation and uses
- water treatment processes
- Product preparation
- syrup production and services
- carbonated product processing and filling equipment

### **1.7.3 Production operations**

- Filling of finished products
- basic principles of filling soft drinks

- stages of the filling process
- common filling problems and fault finding
- Filling syrup for dispense operations
- bag-in-box manufacturing and other types of packaging
- Labelling and coding (including promotions)
- wraparound labelling and sleeving
- date coding
- Warehousing
- storage conditions and stock rotation

#### **1.7.4 Dispense**

- Design and operation of dispense equipment
- Vending machines and planograms
- On-premise hygiene and dispense equipment maintenance
- Dissolved gas and temperature control

#### **1.7.5 Product developments and adaptations**

- Bottled waters
- Functional drinks
- Energy drinks / isotonic

### **1.8 Quality**

#### **1.8.1 Quality control**

- Keg and cask inspection
- Analytical and on-line measurement techniques

#### **1.8.2 Laboratory analysis**

- The basic concepts applied to interpretation of analytical data -  
The relevance of inter-laboratory collaborative checks

#### **1.8.3 Hygiene**

- Microbial contamination
- definition of microbial contamination
- typical microorganisms
- methods of detecting and quantifying residual surface contaminations
- Preventing microbial contamination
- underlying principles
- plant design
- Cleaning in place (CIP)
- CIP principles
- factors affecting cleaning system performance

- composition of soil, scale and biofilms
- microbiology of cleaning
- safety requirements
- Detergents and sanitising agents
- detergent and sanitiser chemistry
- Design and operation of CIP systems
- design principles
- CIP of vessels, pipework and hoses
- types of CIP systems and their optimisation
- Detection and quantification of residual surface contamination

#### **1.8.4 Quality assurance**

- Quality assurance principles and practices
- concept of right first time
- total quality management
- practical application of quality assurance principles
- International standards
- structure and content of relevant standards
- Food safety
- Food legislation
- international and national regulations
- labelling regulations
- Procedures and controls
- risk management
- due diligence
- contamination prevention
- Hazard Analysis Critical Control Point (HACCP)
- hazards in terms of food safety
- key stages in a HACCP analysis
- maintaining a HACCP system

### **1.9 Operations Management**

#### **1.9.1 Line operations**

- Operating practices
- organisational structure, culture, roles and responsibilities
- training needs and development
- interface with other departments
- maintenance
- Measuring performance
- performance measures and their impact on plant efficiency and losses
  - efficiency calculations
- time calculations
- changeovers

#### **1.9.2 World class manufacturing**

- High performance work environments and cultures
- Kaizen, Crosby, Lean and Six Sigma
- examples of world class standards

- Continuous improvement
- the principles of continuous improvement
- techniques for problem solving

### **1.9.3 Finance**

- Basic revenue budgeting
- accounting principles and conventions
- direct and indirect costs
- fixed and variable costs
- construction of departmental budgets
- Management accounting
- annual budgets and period operating statements
- variance reporting
- Project management
- project life cycle
- control of time and cost

### **1.9.4 Purchasing**

- Markets and suppliers
- Specifications and tenders
- Contract management

## **2 MODULE 3**

### **2.1 Resource Management**

#### **2.1.1 Environment**

- Sustainability and climate change
- Energy conservation
- principle energy consuming activities
- energy reduction strategies
- Water conservation
- purposes for water in packaging operation
- water conservation strategies
- Waste minimization
- Packaging waste

#### **2.1.2 Health and safety**

- Fundamental considerations
- health and safety in the food and drink industry
- relevant national and local legislation and regulations
- principle of duty of care
- Management
- organisational structure and responsibilities regarding health and safety
- measuring and reviewing performance and training
- Understanding of workplace hazards and precautions
- techniques for assessing hazards and risks
- safe working practices
- accident investigation and reporting

#### **2.1.3 Utilities**

- Water use and treatment
- different types of water and their uses
- Effluent use and treatment
- Compressed air
- common systems for compressed air production
- components of air distribution systems
- quality requirements for packaging operations
- Managing utilities
- typical utilities usage figures for packaging

#### **2.1.4 Maintenance**

- Aims of maintenance
- Approaches to maintenance
- Maintenance tasks
- types and variety of maintenance tasks in packaging
- Organisation
- planning of maintenance activities
- Performance improvement
- principle performance initiatives

## **2.2 Fluid Mechanics**

### **2.2.1 Principles of fluid mechanics**

- Forms of fluid and fluid energy

-

#### Properties of moving fluids

- Friction loss
- Pumps
- centrifugal pumps
- positive displacement pumps
- cavitation and net positive suction head (NPSH)
- Valves
- design features and merits of different types of valves

### 2.2.2 Process gases

- Gases used and typical applications
- Gas laws
- equations relating to pressure, temperature, volume and density using the perfect gas laws
- universal gas law and gas constant
- Dalton's law of partial pressures
- Gas solubility
- Henry's law and the concept of gas/liquid equilibrium
- gas/liquid solubility and temperature
- effects of hydrostatic head
- Gas dissolution
- principles of dissolving gases in liquids
- typical equipment for measurement and control
- effects of temperature and pressure on carbonation levels in beer
- Carbon Dioxide
- CO<sub>2</sub> recovery and pre-treatment
- liquid CO<sub>2</sub> storage and vaporisation methods
- Nitrogen
- nitrogen specifications
- supply, storage and vaporisation

### 2.3 Heat Transfer

#### 2.3.1 Principles of heat transfer

- Forms of heat energy
- definition of specific heat
- latent heat and exothermic heat
- calculations of energy change
- Heat transfer mechanisms
- conduction, convection and radiation
- calculation of the overall heat transfer coefficient
- effects of fouling and scaling
- Heat exchanger sizing
- concept of the heat balance and heat transfer across a temperature gradient
- co-current and counter-current flow in a heat exchanger



- Plate heat exchanger designs
- construction, components and configuration of a heat exchanger
- importance of fouling/scaling problems
- CIP techniques
- heat exchanger calculations
- heat exchanger applications in packaging

#### Jacketed vessels

- Shell and tube heat exchangers
- shell and tube heat exchanger designs and configurations
- applications in packaging
- Insulation
- function of insulation
- choice of materials

### 2.3.2 Steam

- Steam properties
- reasons for using steam
- temperature-energy relationship as illustrated in the Mollier chart - steam tables
- specific heat of liquid water
- latent heat of vaporisation
- Steam raising and distribution
- boiler design
- pipe sizes, arrangements and design velocities
- insulation
- steam traps
- control valves, reducing valves and relief valves
- legal requirements in having a properly designed, safe system with the correct protection measures
- Principal steam applications

### 2.3.3 Refrigeration

- Refrigeration theory
- definition of refrigeration
- concept of pressure/temperature equilibrium in relation to the vapourcompression refrigeration process
- refrigeration cycle
- function of evaporator, compressor, condenser and expansion valve
- Refrigeration practice and the refrigeration cycle
- Principal plant items
- compressors
- condensers
- evaporator and expansion devices
- Primary refrigerants
- purpose, design and choice
- available refrigerant types and costs
- physical and chemical properties
- Secondary refrigerants

- 
- purpose, design and choice
- chemical properties
- safety and environmental concerns
- Refrigeration applications

## **2.4 Process Control**

### **2.4.1 Process control**

- Basic control elements
- Sensors, controllers and actuators
- Basic on/off control
- Timers, thermostats, pressure switches, proximity switches and others

#### Sequence control

- description of programmable logic controller (PLC)
- examples of plc applications
- Aim of process control
- Principles of process control
- Control arrangements
- Typical control systems
- Actuation
- Control system arrangements
- self-actuating controllers
- individual electronic analogue controls
- small local computer control
- Supervisory Control and Data Acquisition (SCADA), Management Information Systems (MIS) and other large digital systems
- comparative costs

### **2.4.2 Instrumentation**

- Factors determining the choice of sensors
- Typical conventional sensors
- including pressure, volume flow, temperature, mass flow level and vessel contents
- Typical analytical sensors
- including CO<sub>2</sub>, O<sub>2</sub>, optical devices, pH, density and alcohol content

## **2.5 Materials of Construction**

### **2.5.1 Classification and properties**

- Carbon and low alloy steels
- Stainless steels
- Other metals including copper (and alloys), aluminium and cast iron -  
Plastics and glass

### **2.5.2 Applications and limitations**

- Advantages and disadvantages
- Applications