The Diploma in Brewing

Examination Syllabus

1 MODULE 1

1.1 Brewing Raw Materials

1.1.1 Malt

- Barley kernel structure and morphology
- The malting process and its impact on malt quality
- Malt quality and brewing performance
- Typical specifications for base malts, their methods of analysis and their relevance for predicting wort composition, extract efficiency and brewery performance
- Speciality malts and their basic principles of manufacture, application and typical specifications

1.1.2 Adjuncts

- The range of adjuncts available and their typical composition
- Their basic principles of manufacture
- The applications of adjuncts in brewing
- Typical specifications for adjuncts, their methods of analysis and their relevance for predicting wort composition, extract efficiency and brewery performance

1.1.3 Water

- Characteristics and composition
- Typical specifications and their relevance for the brewing process
- The principles, functions and respective merits of methods for treating brewing water
- The basic principles of design and operation of water treatment plants
- Typical specifications for brewing water, methods of analysis and their relevance for brewing quality

1.1.4 Hops

- Selecting hops
- Hop constituents relevant to brewing
- Processed hop products and their basic principles of manufacture
- The use of hops and hop products throughout the brewing process
- Typical specifications for hops and hop products, their methods of analysis and their relevance for brewing quality

1.2 Milling

1.2.1 Malt intake, handling and storage

- The basic principles and operation of malt intake, handling and storage

1.2.2 Milling equipment and process

- The basic principles of milling

- The design and operational principles of mills
- Criteria for mill selection

1.3 Mashing and Wort Separation

1.3.1 Principles and purpose of mashing

- The key enzymic processes underlying the conversion of malt and adjuncts to fermentable wort
- The design and operational principles of mashing systems

1.3.2 Principles and purpose of wort separation

- The principles of filtration applied to wort separation
- The design and operational principles of wort separation systems
- The impact of mashing and wort separation on brewery throughput, yield and quality

1.4 Wort Boiling

1.4.1 Principles and purpose of boiling

- The chemical changes that take place during boiling and their impact on product quality

1.4.2 Design and operation of kettles

- The design and operational principles of kettles
- Criteria for kettle selection

1.5 Wort Clarification, Cooling and Oxygenation

1.5.1 Wort clarification

- The design and operational principles of wort clarification systems - Criteria for clarification system selection

1.5.2 Wort cooling and oxygenation

- The design and operational principles of wort cooling and oxygenation systems
- Criteria for cooling system selection
- Criteria for oxygenation system selection

2 MODULE 2

2.1 Yeast Fundamentals

2.1.1 Yeast morphology

- Key features and functions of a yeast cell
- Mechanism of growth and cell division
- Genetic characteristics of yeast
- The outline of genetic tests for typing yeasts

2.1.2 Characteristics of brewing yeast

- Methods of characterising and evaluating brewing yeast using biochemical, microbiological and small-scale fermentation testing

2.1.3 Carbohydrate metabolism

- The selective mechanisms for transferring carbohydrate through the cell wall and conversion to fermentable sugars
- The carbohydrates not utilisable by normal brewing yeasts
- The basic differences between aerobic and anaerobic carbohydrate metabolism
- The main purpose and effects of the Embden-Meyerhof-Parnas pathway
- The significance of pyruvate in the metabolic chain
- The importance of glycerol production in NAD/NADH balance
- The importance of the pentose-phosphate pathway

2.1.4 Production of flavour compounds

- The biochemical mechanisms, flavour descriptors and thresholds for compounds produced during fermentation

2.1.5 Basic nutritional requirements of yeast

- The nutritional factors necessary to promote effective fermentation and healthy yeast

2.2 Fermentation

2.2.1 Principal fermentation variables

- Control parameters and value ranges throughout fermentation

2.2.2 The effect of fermentation variables

- The effect of fermentation control parameters on fermentation performance and the formation of beer flavour components

2.2.3 Principles of design and operation of fermenting vessels

- The design and operational principles of fermenting vessels
- Criteria for fermenting vessel selection
- The design and operational principles of fermentation systems

2.3 Yeast in Brewing

2.3.1 Yeast cultures

- The principles of isolating pure cultures
- The principles of preserving pure cultures in the laboratory
- The principles of design and operation of yeast propagation systems

2.3.2 Measurement of quantity and quality

- Methods for measuring yeast concentration
- Methods for assessing yeast viability and vitality
- Measurement and calculation of yeast growth during fermentation

2.3.3 Yeast handling and management

- The principles and design of yeast handling systems
- Selection criteria for yeast pitching

2.3.4 Physical behaviour of yeast

- The basic principles of yeast flocculation, sedimentation and adhesion

2.4 Maturation and Cold Storage

2.4.1 General principles:

- The design and operational principles of maturation systems designed for beer processing above 0°C
- The design and operational principles of cold storage systems designed for beer processing below 0°C

2.4.2 Processing aids

- The nature, purpose, function and application of processing aids

2.4.3 Additions to beer

- The nature, purpose, function and application of additions to beer

2.5 Beer Clarification

2.5.1 Sedimentation

- The theory of sedimentation

2.5.2 Centrifugation

- The theory of centrifugal sedimentation
- The design and operational principles, of centrifuges and their application in breweries

2.5.3 Filtration

- The theory of filtration
- The design and operational principles of filtration systems - The nature, purpose, function and application of filter aids
- Criteria for filter selection
- The effect of filtration control parameters on filter performance and filtered beer quality

2.6 The Properties of Beer

2.6.1 Beer hazes

- The nature and typical composition of biological, chill and permanent hazes
- The scientific principles behind, and relevance of, process factors in nonbiological haze formation
- The measurement of non-biological haze
- The prediction of shelf-life using accelerated haze formation techniques

2.6.2 Beer foam

- The physical principles of foam formation, collapsing and lacing
- Methods for measuring foam quality
- Factors affecting foam performance
- The nature, purpose, function and application of foam stabilisers

2.6.3 Colour in beer

- Factors affecting beer colour

2.6.4 Gushing in beer

- Factors affecting gushing

2.6.5 Beer flavour components

- The nature and contribution to beer flavour of raw materials
- The nature and origin of common flavour taints

2.6.6 Flavour stability

- The nature of flavour changes which occur during beer storage
- The importance of oxidation in causing flavour instability
- Control of oxidation throughout the brewing process
- The nature, purpose, function and application of anti-oxidants

2.6.7 Types of beer microorganisms

- Microorganisms which can be intentionally added to wort and beer and their application
- Spoilage microorganisms and their effects on beer quality

2.6.8 Control factors

- Factors that affect susceptibility/tolerance of microorganisms to grow in wort or beer

2.6.9 Detection methods

- The principles of detection and quantification of microorganisms.

2.7 Quality

2.7.1 Quality management

- Quality control principles and practices
- Quality assurance principles and practices

2.7.2 Laboratory analysis

- Analytical techniques for wort and beer
- The basic concepts applied to interpretation of analytical data

2.7.3 Sensory analysis

- Basic sensory techniques and their use in brewing

2.7.4 Hygiene

- The design and operational principles of hygienic brewing plants
- The design and operational principles of Cleaning-in-Place (CIP) systems
- The nature, purpose, function and application of detergents and sanitisers - Measurement of cleaning effectiveness

3 MODULE 3

3.1 Resource Management

3.1.1 Environment

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

3.1.2 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

3.1.3 Utilities

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

3.1.4 Maintenance

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

3.2 Fluid Mechanics

3.2.1 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

3.2.2 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_2 recovery and pre-treatment
- liquid CO_2 storage and vaporisation methods
- Nitrogen
- nitrogen specifications
- supply, storage and vaporisation

3.3 Heat Transfer

3.3.1 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 brewing - Jacketed vessels
- Shell and tube heat exchangers
- shell and tube heat exchanger designs and configurations
- applications in brewing
- Insulation
- function of insulation
- choice of materials

3.3.2 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 vales and relief valves
- legal requirements in having a properly designed, safe system with the correct protection measures
- Principal steam applications

3.3.3 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

3.4 Process Control

3.4.1 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

3.4.2 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_2, O_2, optical devices, pH, density and alcohol content

3.5 Materials of Construction

3.5.1 Classification and properties

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

3.5.2 Applications and limitations

- Advantages and disadvantages
- Applications

3.6 Packaging

3.6.1 Small packaging

- Basic principles of design and operation of a filler to fill bottles and cans
- Basic plant features and control procedures from filtration through to filled containers
- The basic principles of pasteurisation and the additional precautions required for a sterile operation from filtration through to sealed container

3.6.2 Large packaging

- Basic principles of design and operation of a filler to fill kegs
- Basic plant features and control procedures from filtration through to filled containers