The Diploma in Brewing

Examination Syllabus 2018
<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.6.7</td>
<td>Types of beer microorganisms</td>
<td>5</td>
</tr>
<tr>
<td>2.6.8</td>
<td>Control factors</td>
<td>5</td>
</tr>
<tr>
<td>2.6.9</td>
<td>Detection methods</td>
<td>5</td>
</tr>
<tr>
<td>2.7</td>
<td>Quality</td>
<td>5</td>
</tr>
<tr>
<td>2.7.1</td>
<td>Quality management</td>
<td>5</td>
</tr>
<tr>
<td>2.7.2</td>
<td>Laboratory analysis</td>
<td>5</td>
</tr>
<tr>
<td>2.7.3</td>
<td>Sensory analysis</td>
<td>5</td>
</tr>
<tr>
<td>2.7.4</td>
<td>Hygiene</td>
<td>5</td>
</tr>
<tr>
<td>3</td>
<td>MODULE 3</td>
<td>6</td>
</tr>
<tr>
<td>3.1</td>
<td>Resource Management</td>
<td>6</td>
</tr>
<tr>
<td>3.1.1</td>
<td>Environment</td>
<td>6</td>
</tr>
<tr>
<td>3.1.2</td>
<td>Health and safety</td>
<td>6</td>
</tr>
<tr>
<td>3.1.3</td>
<td>Utilities</td>
<td>6</td>
</tr>
<tr>
<td>3.1.4</td>
<td>Maintenance</td>
<td>6</td>
</tr>
<tr>
<td>3.2</td>
<td>Fluid Mechanics</td>
<td>6</td>
</tr>
<tr>
<td>3.2.1</td>
<td>Principles of fluid mechanics</td>
<td>6</td>
</tr>
<tr>
<td>3.2.2</td>
<td>Process gases</td>
<td>7</td>
</tr>
<tr>
<td>3.3</td>
<td>Heat Transfer</td>
<td>7</td>
</tr>
<tr>
<td>3.3.1</td>
<td>Principles of heat transfer</td>
<td>7</td>
</tr>
<tr>
<td>3.3.2</td>
<td>Steam</td>
<td>8</td>
</tr>
<tr>
<td>3.3.3</td>
<td>Refrigeration</td>
<td>8</td>
</tr>
<tr>
<td>3.4</td>
<td>Process Control</td>
<td>8</td>
</tr>
<tr>
<td>3.4.1</td>
<td>Process control</td>
<td>8</td>
</tr>
<tr>
<td>3.4.2</td>
<td>Instrumentation</td>
<td>9</td>
</tr>
<tr>
<td>3.5</td>
<td>Materials of Construction</td>
<td>9</td>
</tr>
<tr>
<td>3.5.1</td>
<td>Classification and properties</td>
<td>9</td>
</tr>
<tr>
<td>3.5.2</td>
<td>Applications and limitations</td>
<td>9</td>
</tr>
<tr>
<td>3.6</td>
<td>Packaging</td>
<td>9</td>
</tr>
<tr>
<td>3.6.1</td>
<td>Small packaging</td>
<td>9</td>
</tr>
<tr>
<td>3.6.2</td>
<td>Large packaging</td>
<td>9</td>
</tr>
</tbody>
</table>
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 non-biological 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
  - CO₂ recovery and pre-treatment
  - liquid CO₂ 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 valves 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 vapour-compression 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 CO₂, O₂, 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