The Fundamentals of Distilling (FD)

Learning Material © Institute of Brewing and Distilling 2013
EXAMINATION SYLLABUS

INTRODUCTION

The Certificate in the Fundamentals of Distilling (FD) requires a basic knowledge of the processes used to produce and package the many types of distilled spirits consumed worldwide. The production of most distilled products involves many common features and the purpose of this qualification is to provide a basic grounding in the technical features of the distillation processes for both distillery production personnel and for people employed in distilling companies (and related industries), but in non-technical roles.

The scope of the FD syllabus provides an introduction to the technology common to all aspects of distilled products production, but also allows candidates to select, in one syllabus section, to study some specific details related to the production of the principal distilled products (viz. whisk(e)y, brandy, rum and neutral spirit (for gin/vodka).

The examination will be based on a single 2 hour paper, comprising 50 Multiple Choice Questions based on all syllabus sections, but allows candidates the choice, where relevant, of answering some selective questions.

The full list of sections in the FD syllabus is:

1. Overview – general features of the range of product types:
   - Whisk(e)y, Brandy, Rum, Gin, and Vodka.
2. Raw Materials of the Principal Potable Spirits
3. Fermentation Theory
4. Fermentation Technology
5. Fundamentals of Distillation
6. Distillation Technology – Batch and Continuous
7. Specific Production Details for Different Distilled Spirits,
   - Malt and Grain Whisk(e)y
   - Brandy
   - Rum
   - Gin and Vodka.
8. Maturation and Blending
9. Packaging
10. Distillery Co-Products
11. Quality Management Systems
12. Quality - Process Control
13. Quality – Flavour
14. Quality – Hygiene and Cleaning Systems
15. Plant Maintenance Philosophy
16. Health and Safety
17. Distilling and the Environment
**Syllabus Section 1: An Overview of Distilled Products**

**Summary of knowledge required for this section:**
A. A general knowledge of the different types of potable distilled spirits and their characteristics and the methods of production which differentiate them.
B. A familiarity with principal stages of the distilling processes.
C. A basic understanding of the technical terms used in distilling.

**The required learning outcomes**

<table>
<thead>
<tr>
<th>Syll. Ref.</th>
<th>Topics</th>
<th>Candidates should understand and be able to explain and describe in simple terms, or demonstrate familiarity with:</th>
</tr>
</thead>
</table>
| 1.1       | General knowledge of types of potable distilled spirits and their characteristics. | The generic, often legalistic, definitions and outline specifications of potable distilled spirits worldwide.  
The range of spirits and their respective styles and characters.  
Outline knowledge of their typical compositions and methods of production. |
| 1.2       | General knowledge of the processes used in the production of distilled spirits. | The sequence of events from raw material processing to the finished product.  
A visualisation of raw materials handling, fermentation, distillation, maturation and packaging processes as a flow diagram. |
| 1.3       | Technical terms | A basic understanding of the technical terms used in distilling. |

**Syllabus section 2: Raw Materials of the Principal Potable Spirits**

**Summary of knowledge required for this section:**
A. A basic knowledge of the raw materials of the principal potable spirits
B. Processing of cereals, grapes and sugar cane for production of fermentable sugars.

**The required learning outcomes**

<table>
<thead>
<tr>
<th>Syll. Ref.</th>
<th>Topics</th>
<th>Candidates should understand and be able to explain and describe in simple terms, or demonstrate familiarity with:</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>General knowledge of the principal raw materials.</td>
<td>The characteristics and differentiation of the primary ingredients, basic raw materials and their processing, prior to fermentation, for the principal different types of spirits.</td>
</tr>
</tbody>
</table>
| 2.2       | The major cereals and the sources of enzymes for production of whisky (whiskey) and for Grain Neutral Spirit. | The basic cereals and their processing to produce “wort” for fermentation.  
Outline of the production of malted barley.  
Different component cereals producing different products.  
Conversion of cereal starch to fermentable sugars. |
| 2.3       | Grapes and Wine for Brandy and Neutral Spirit Production | Cultivation of Grape vines and the varieties used.  
Harvesting and pressing of grapes.  
The production and treatment of “must” (grape juice). |
| 2.4       | Sugar Cane and Molasses for Rum and Neutral Spirit Production | Refining of sugar cane.  
Production of molasses.  
Treatment and composition of molasses. |
Syllabus section 3: Fermentation Theory

Summary of knowledge required for this section:
A. Familiarity with the names, morphology and nutritional requirements of yeasts.
B. An appreciation of basic fermentation theory as applied to distilled products.
C. An awareness of the differences associated with pure culture yeasts and “natural” fermentations.

The required learning outcomes

<table>
<thead>
<tr>
<th>Syll. Ref.</th>
<th>Topics</th>
<th>Candidates should understand and be able to explain and describe in simple terms, or demonstrate familiarity with:</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1</td>
<td>Principles of alcoholic fermentations</td>
<td>The principal fermentable sugars. Conversion of sugars into ethyl alcohol (ethanol) and carbon dioxide (CO2). Relationship between initial sugar concentration and final yield of ethanol. Production of small amounts of by-products of fermentation which contribute to the flavour and aroma of the fermented wash. Nutritional requirements of distilling yeast: sugars, amino acids, mineral salts, vitamins Changes in concentration of yeast, sugar and alcohol over the course of fermentation. Production of flavour congeners, acids and heat.</td>
</tr>
<tr>
<td>3.2</td>
<td>Yeasts and pitching yeast quality</td>
<td>Significance of the name <em>Saccharomyces cerevisiae</em>. Structure and appearance of yeast cells Function of the principal structures of the yeast cell Mechanism of yeast growth by budding The requirement for yeast of good viability and vitality and with a low level of infection. The effect of poor yeast quality on the fermentation and subsequent spirit yield.</td>
</tr>
<tr>
<td>3.3</td>
<td>Pure culture yeast and “natural” fermentations</td>
<td>Propagation of a pure yeast culture. Different types of yeast: cake, cream and dried; use of dried yeast and re-hydration methods. Procedures for pitching (inoculating) of wort with these types of yeast. Advantages and disadvantages of spontaneous (“natural”) fermentation.</td>
</tr>
<tr>
<td>3.4</td>
<td>Role of other micro-organisms</td>
<td>Influence on pH and positive and negative influences on flavour. The role of <em>Lactobacillus</em> in spirit fermentations and its effect on flavour</td>
</tr>
</tbody>
</table>

Syllabus section 4: Fermentation Technology

Summary of knowledge required for this section:
A. Familiarity with typical fermentation installations.
B. An understanding of how fermentations are controlled.

The required learning outcomes

<table>
<thead>
<tr>
<th>Syll. Ref.</th>
<th>Topics</th>
<th>Candidates should understand and be able to explain and describe in simple terms, or demonstrate familiarity with:</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.1</td>
<td>Design, construction and operation of fermentation vessels</td>
<td>Structure of fermentation vessels constructed of wood, steel or stainless steel. Operating principles. Importance of sterilization of fermenters, yeast mixing vessel and associated pipe work</td>
</tr>
<tr>
<td>4.2</td>
<td>Fermentation control: Influence of temperature</td>
<td>Significance of temperature at pitching with yeast. Practical aspects of the phases of typical temperature profiles. Importance of ”setting temperature” to control maximum temperature during fermentation.</td>
</tr>
<tr>
<td>4.3</td>
<td>Typical fermentation conditions and progress of fermentation</td>
<td>Procedures to control and monitor fermentation Significance of specific gravity and pH measurements during fermentation.</td>
</tr>
</tbody>
</table>
Syllabus section 5: Fundamentals of Distillation

Summary of knowledge required for this section:
A. Familiarity with the theory of distillation.
B. An understanding of the basic concepts of batch and continuous distillation.
C. An appreciation of the role of copper.

The required learning outcomes

<table>
<thead>
<tr>
<th>Syll. Ref.</th>
<th>Topics</th>
<th>Candidates should understand and be able to explain and describe in simple terms, or demonstrate familiarity with:</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.1</td>
<td>Theory of distillation</td>
<td>Liquid/ vapour equilibrium – understanding of the graphic model. Volatility of components. The reason why distillation alone cannot achieve 100% pure ethanol (alcohol).</td>
</tr>
<tr>
<td>5.2</td>
<td>Basic concepts of batch and continuous distillation</td>
<td>Meaning of the terms “batch” and “continuous” distillation. Outline descriptions of both processes</td>
</tr>
<tr>
<td>5.3</td>
<td>The role of copper</td>
<td>Use in stills and condensers to remove sulphur compounds. Other reasons to use copper: malleability, heat conductivity, corrosion resistance, soldering</td>
</tr>
</tbody>
</table>

Syllabus section 6: Distillation Technology – Batch and Continuous

Summary of knowledge required for this section:
A. Familiarity with typical batch (pot) and continuous distillation installations.
B. An understanding of how distillations are controlled to produce correct product specification.
C. An appreciation of the design and operation of continuous stills for Neutral Spirit (NS) production.

The required learning outcomes

<table>
<thead>
<tr>
<th>Syll. Ref.</th>
<th>Topics</th>
<th>Candidates should understand and be able to explain and describe in simple terms, or demonstrate familiarity with:</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.1</td>
<td>Basic operation of batch (pot) stills.</td>
<td>The basic double distillation process; outline comparison with triple distillation systems. Basic construction and design of stills and their operation. Effect of speed of distillation, reflux and still design on alcohol concentration and congeners. Cut points to control flavour. Reflux and the distillation of flavour congeners. The design and operation of condensers – worm tub (serpentines) and shell and tube. The design of the spirit safe and procedures for the collection of low wines, spirit and heads and tails.</td>
</tr>
</tbody>
</table>
## Syllabus Section 7: Specific Production Details for Different Distilled Spirits

### Summary of knowledge required for this section:
A. An basic understanding of some specific production details for:
   - Malt and Grain whiskies
   - Brandy
   - Rum
   - Gin and Vodka

### The required learning outcomes

<table>
<thead>
<tr>
<th>Syll. Ref.</th>
<th>Topics</th>
<th>Candidates should understand and be able to explain and describe in simple terms, or demonstrate familiarity with:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Topics</strong></td>
<td><strong>(Number of questions to be answered = 5)</strong></td>
</tr>
</tbody>
</table>
| 7.1        | Malt Whisky                                 | The principles of mashing; the origin of the fermentable sugars of wort, and their significance.  
The purpose and practice of separating malt distillery wort from the (spent) grains  
The importance of preservation of enzymes for activity in the washback.  
Batch (pot) distillation for malt whisky:  
   - Operation of pot stills for malt whisky and similar whiskies. |
| 7.2        | Grain Whisky/GNS                            | The options and purpose of cereal processing:  
   Gelatinization of the starch of maize (and possibly wheat) prior to mashing.  
Batch or continuous processing.  
The options for mashing and mash separation (“grains in” or “grains out”).  
The origin of the fermentable sugars of wort, and their significance.  
The reasons why exogenous enzymes are permitted to prepare wort for neutral spirit/gin/ vodka production but not for Scotch whisky wort.  
Continuous (column) distillation for grain whisky:  
   Design and operation of a two still system - Coffey still or Beer Stripper/Rectifier set-up  
   Composition and preheating of the feed. |
| 7.3        | Brandy                                      | Details of wine fermentation and use of purchased wines as feedstock.  
Operation of batch (pot) stills for cognac and similar brandies, both single and double distillation process:  
   Design of the simple alembic still;  
   Time constraints on distillation for Cognac production.  
Operation of the column distillation process:  
   The design and operation of:  
   - Armagnac still and Two column still (e.g. Barbet still). |
| 7.4        | Rum                                         | Operation of batch stills (pot) for heavy rum production:  
   Design of the stills, including batch pot and column arrangement for heavy type rum production.  
Sequential batch – beer, low wine, high wine – stills for rum.  
Operation of the two column distillation process:  
   The design and operation of column still set-ups:  
   a. Two column (Coffey type) still and  
   b. Barbet still and concentrator |
| 7.5        | Gin and Vodka production from NS and methods of use for gin production | Quality standards of neutral spirit feedstock for gin and vodka production.  
The principal Botanicals (plant materials) used for the flavouring of gin; how essential oils are preserved, and how and why botanicals are used in gin distillation.  
Production of flavouring extracts by solvent extraction or distillation for compounded gin.  
Production of vodka from neutral spirit.  
Requirement for removal of flavour congeners by re-distillation or charcoal (carbon) filtration. |
Syllabus section 8: Maturation and Blending

Summary of knowledge required for this section:

A. An understanding of the role of storage in wooden casks.
B. An understanding of the need to “finish” spirit flavour and the use of flavourings, if permitted.
C. An awareness of the flavour changes occurring during maturation.
D. An understanding of the need for blending to ensure taste consistency.

The required learning outcomes

<table>
<thead>
<tr>
<th>Syll. Ref.</th>
<th>Topics</th>
<th>Candidates should understand and be able to explain and describe in simple terms, or demonstrate familiarity with:</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.1</td>
<td>Role of wood and wood treatment; finishes</td>
<td>Main types of cask wood: American and European oak. Reasons for use of these woods: no leakage, contribution to flavour. Surface/volume ratio of different types of cask. Storage conditions, especially temperature and humidity. For whisky: use of treated cask, or casks used previously to hold another beverage (e.g. port, sherry, wine etc.) to produce whisky “finishes”.</td>
</tr>
<tr>
<td>8.2</td>
<td>Changes occurring in the spirit over the process of maturation.</td>
<td>Characteristics of new and mature spirit. Immature characters to be removed. Desirable mature characteristics. Evaporation (loss of high-volatile congeners). Absorption into char layer of wood surface. Extraction of colour and flavour compounds from wood (e.g. vanillin). Reactions within the maturing spirit, e.g. oxidation, formation of esters.</td>
</tr>
<tr>
<td>8.3</td>
<td>Blending and flavourings..</td>
<td>Reasons for blending: improving the drinkability of the spirit; targeting a particular market, balancing light and heavy flavours, ensuring consistency of taste and appearance and quality in the final product. Organisation of stock. Choice of spirits, emptying casks, filtration, mixing, the importance of tasting and/or chemical analysis at critical points in the process. <strong>For rum:</strong> Use of caramel in rum production; use of flavours and essences to produce rum based products.</td>
</tr>
</tbody>
</table>
Syllabus section 9: Packaging

Summary of knowledge required for this section:

A. An awareness of the factors involved in preparing spirits for packaging.
B. Familiarity with the configuration of the principal packaging equipment items.
C. An understanding of the purposes of package labeling, including bar coding.

The required learning outcomes

<table>
<thead>
<tr>
<th>Syll. Ref.</th>
<th>Topics</th>
<th>Candidates should understand and be able to explain and describe in simple terms, or demonstrate familiarity with:</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.1</td>
<td>Spirit preparation for packaging</td>
<td>The process and equipment used to: Reduce the spirit to bottling strength - reduction water quality. Adjust the colour to specification Chill filtration to remove haze and floc. Attemporation to filling temperature</td>
</tr>
<tr>
<td>9.2</td>
<td>Unit processes of packaging</td>
<td>Control of in-coming raw materials Processes of bottle rinsing, filling, capping/sealing, labeling, inspection, packing, case sealing and palletisation.</td>
</tr>
<tr>
<td>9.3</td>
<td>Identification and protection of packages and the detection and prevention of fraud</td>
<td>Lot marking, bar coding and date stamping. Use of secondary and tertiary packaging for product protection. Use of tamper evident seals, non-refillable fitments and tax strips and labels. Analysis of components specific to a brand.</td>
</tr>
</tbody>
</table>

Syllabus Section 10: Distillery Co-Products

Summary of knowledge required for this section:

A. An understanding of the range of co-products available from different distilling operations.
B. Familiarity with the use and disposal of still residues.
C. Familiarity with the significance of production of CO₂.
D. Familiarity with specific co-products and their potential value.

The required learning outcomes

<table>
<thead>
<tr>
<th>Syll. Ref.</th>
<th>Topics</th>
<th>Candidates should understand and be able to explain and describe in simple terms, or demonstrate familiarity with:</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.1</td>
<td>Range of distillery co-products</td>
<td>Spent grains (draff) from malt distillery mashing Carbon dioxide from grain distillery fermentation Pot ale from malt whisky wash distillation &quot;Marc&quot;/&quot;Pomace&quot; from grape pressing and fermentation lees. Spent wash/stillage from continuous distillation. &quot;Fusel oil&quot; from continuous distillation. Recovery of copper from spent lees. Awareness of other waste streams of no commercial value: CO₂, spent lees.</td>
</tr>
<tr>
<td>10.2</td>
<td>Use and disposal of still residues</td>
<td>Specific products - Preparation of animal feed Concentration of pot ale to syrup. Dark grains preparation and drying: Energy-saving implications of multiple-effect evaporation</td>
</tr>
</tbody>
</table>
### Syllabus section 11: Quality Management Systems

#### Summary of knowledge required for this section:

A. Familiarity with the basic principles and benefits of a quality management system.
B. An awareness of the organisational implications of a quality system.
C. An awareness of product safety systems (e.g. HACCP)

#### The required learning outcomes

<table>
<thead>
<tr>
<th>Syll. Ref.</th>
<th>Topics</th>
<th>Candidates should understand and be able to explain and describe in simple terms, or demonstrate familiarity with:</th>
</tr>
</thead>
</table>
| 11.1       | Description of basic quality systems; benefits, roles and responsibilities | The key features of a quality system viz.:  
- written specifications  
- written procedures  
- document control  
- monitoring of performance  
- corrective actions  
- auditing  
- regular reviews for improvement.  
The business benefits of an effective quality management system.  
The impact of individual actions on product and service quality.  
The control of documentation.  
The maintenance of conformity. |
| 11.2       | Product safety: HACCP (Hazard Analysis and Critical Control Points) | Product and process control procedures to ensure product safety. |

### Syllabus section 12: Quality - Process Control

#### Summary of knowledge required for this section:

A. An understanding of the expression of quality as the realization of a specification.
B. An understanding of process and product specifications.
C. An appreciation of the practices necessary for quality control.

#### The required learning outcomes

<table>
<thead>
<tr>
<th>Syll. Ref.</th>
<th>Topics</th>
<th>Candidates should understand and be able to explain and describe in simple terms, or demonstrate familiarity with:</th>
</tr>
</thead>
</table>
| 12.1       | Product consistency | The variable nature of natural ingredients.  
The influence of process parameters on final product.  
The principles of monitoring and adjustment to achieve product consistency.  
The concept of ‘trueness to type.’  
Simple statistical quality control procedures. |
| 12.2       | Quality parameters - process and end product | The key parameters to be measured, their units of measure and their influence on quality, such as sensory, spirit alcohol, colour, chill haze analysis.  
Factors affecting these parameters during production.  
The purpose of a specification.  
The concepts of tolerance and range for specification parameter values. |
Syllabus section 13: Quality – Sensory Evaluation

Summary of knowledge required for this section:

A. Familiarity with the terminology for describing flavours.
B. An appreciation of the methods of evaluating flavour.

The required learning outcomes

<table>
<thead>
<tr>
<th>Syll. Ref.</th>
<th>Topics</th>
<th>Candidates should understand and be able to explain and describe in simple terms, or demonstrate familiarity with:</th>
</tr>
</thead>
<tbody>
<tr>
<td>13.1</td>
<td>Sensory evaluation.</td>
<td>The reasons for adopting industry standard descriptors for aroma and taste. The more commonly used descriptors of the flavour wheel. Common faults / contamination that may be detected by tasting during production operations.</td>
</tr>
<tr>
<td>13.2</td>
<td>Evaluation procedures</td>
<td>Difference testing procedures (e.g. the three-glass test). Flavour profiling and descriptive testing (e.g. trueness to type panel testing).</td>
</tr>
</tbody>
</table>

Syllabus topic 14: Quality – Plant Hygiene and Cleaning Systems

Summary of knowledge required for this section:

A. An appreciation of the vulnerability of product streams to microbiological contamination and the potential risks and an awareness of how microbiological contamination can be detected.
B. An appreciation of the constituents and modes of action of detergents and sterilants.
C. The design and operating principles of in-place cleaning (CIP) systems.

The required learning outcomes

<table>
<thead>
<tr>
<th>Syll. Ref.</th>
<th>Topics</th>
<th>Candidates should understand and be able to explain and describe in simple terms, or demonstrate familiarity with:</th>
</tr>
</thead>
<tbody>
<tr>
<td>14.1</td>
<td>Microbiological control</td>
<td>Health risks and control of Legionella pneumophilia in cooling water towers and other warm service waters. Water-borne bacteria (e.g. Esherichia coli) and the implications of their presence. Microbiological control of yeast handling systems Microbiological control of reduction and process waters. Positive and negative aspects of lactic acid bacteria in a distillery.</td>
</tr>
<tr>
<td>14.2</td>
<td>Detergents, sterilants and cleaning systems (including cleaning-in-place (CIP) systems.</td>
<td>The chemical nature of typical detergents and sterilants. The influence of time, temperature and concentration. The operating principles and diagrammatic representation of typical CIP systems. Design features which promote an hygienic working environment.</td>
</tr>
</tbody>
</table>
Syllabus section 15: Plant Maintenance Philosophy.

Summary of knowledge required for this section:

A. An appreciation of the reasons for the importance of an effective maintenance system.
B. An appreciation of the systems or approaches available.
C. An appreciation of performance orientated maintenance systems.

The required learning outcomes

<table>
<thead>
<tr>
<th>Syll. Ref.</th>
<th>Topics (Number of questions to be answered = 1)</th>
<th>Candidates should understand and be able to explain and describe in simple terms, or demonstrate familiarity with:</th>
</tr>
</thead>
<tbody>
<tr>
<td>15.1</td>
<td>Approaches and tasks</td>
<td>The business motives for an effective maintenance system.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The relationship between corrective and preventative maintenance.</td>
</tr>
<tr>
<td>15.2</td>
<td>Performance improvement</td>
<td>The key features of a typical performance orientated maintenance system.</td>
</tr>
</tbody>
</table>

Syllabus section 16: Health and Safety

Summary of knowledge required for this section:

A. An appreciation of all health and safety considerations in a distillery, including the fermentation area.
B. An appreciation of the practices for the safe handling of chemicals.
C. An awareness of health and safety issues relating to packaging lines.

The required learning outcomes

<table>
<thead>
<tr>
<th>Syll. Ref.</th>
<th>Topics (Number of questions to be answered = 2)</th>
<th>Candidates should understand and be able to explain and describe in simple terms, or demonstrate familiarity with:</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td>Health and Safety</td>
<td>Industry standards and personnel issues:</td>
</tr>
<tr>
<td>16.1</td>
<td>- Carbon dioxide</td>
<td>The evolution of carbon dioxide from fermentation vessels and the hazards associated with carbon dioxide and the observance of safety precautions.</td>
</tr>
<tr>
<td>16.2</td>
<td>- Fire and explosion risks</td>
<td>Flammability and explosion risks of alcohol during distillation.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fire and explosion dangers at stills, in storage and operations involving spirits.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dust explosion and health risks.</td>
</tr>
<tr>
<td>16.3</td>
<td>- Steam</td>
<td>The potential dangers of steam and steam distribution systems.</td>
</tr>
<tr>
<td>16.4</td>
<td>- Chemicals</td>
<td>The hazards associated with chemical cleaning and sterilising agents.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Good practices for the storage and handling of chemicals.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Use of personal protective clothing.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Procedures in case of accidental spillage or discharge of chemicals.</td>
</tr>
<tr>
<td>16.5</td>
<td>- Packaging</td>
<td>Awareness of all health and safety issues relating to packaging lines.</td>
</tr>
</tbody>
</table>
## Syllabus section 17: Distilling and the Environment

### Summary of knowledge required for this section:

A. An awareness of the impact of distillation processes on the environment.  
B. An awareness of practices to reduce environmental impact

<table>
<thead>
<tr>
<th>Syll. Ref.</th>
<th>Topics</th>
<th>Candidates should understand and be able to explain and describe in simple terms, or demonstrate familiarity with:</th>
</tr>
</thead>
</table>
| 17.1      | Sustainability and climate change. | The concept of a sustainable industry.  
The role of carbon dioxide – the carbon cycle.  
Sources of carbon dioxide emissions in distilling. |
| 17.2      | Energy conservation | The principal energy consuming activities in a distillery.  
Typical energy reduction strategies.  
Main uses of steam in distilling.  
Hot water recovery systems. |
| 17.3      | Water quality and water conservation | Sources of water: borehole, surface, municipal/ public.  
Principal water consuming activities: process water, utility water, cooling water and their specification.  
Reliability and consistency of supply.  
Appearance, odour and taste.  
Dissolved salts and their importance.  
Typical water conservation strategies: reuse, recovery and conservation considerations in the use of water. |
| 17.4      | Waste streams – effluent and packaging waste | Sources of effluent and control strategies.  
Government controls on discharge to the environment and to public sewer.  
Factors affecting decision on in-house or off-site treatment.  
Charging systems and their influence on above decision.  
Strategies to minimize packaging material and encourage recycling. |