Institute of Brewing & Distilling

# The General Certificate in Distilling (GCD)

# Examination Syllabus

## (valid from November 2009)

## Includes Elective Options for:

- **GCD (Cereal)**
- **GCD (Sugar Cane Molasses)**
- **GCD (Grape)**

**This document details the course of study necessary to prepare for the examination for the GCD (Cereal, Sugar Cane Molasses and Grape options). The specifications to which the respective examination papers are prepared are also shown.**

# GENERAL CERTIFICATE IN DISTILLING

# INTRODUCTION

General Certification in Distilling (GCD) requires a basic knowledge of the processes used to produce the main types of potable spirit consumed worldwide. The scope of the present GCD syllabus is therefore confined to spirits derived either from cereals, cane sugar and cane sugar molasses, and grapes. The generic descriptors "whisk(e)y", "rum" and "brandy" are consequently restricted to beverages made from those respective raw materials. Similarly, neutral spirits derived from the same sources and vodka and gin made from neutral spirit are the only other products covered in the following syllabus. More detailed national and legal specifications of these potable spirits are to be found in Section 1 (Overview and Glossary) of the Revision Notes.

The General Certificate in Distilling allows candidates to qualify for certification in the following electives:

- GCD (Cereal)
- GCD (Sugar Cane Molasses)
- GCD (Grape)

The elective format contains a common or "core" section (of 14 modules) that will be studied by all candidates, and elective sections (each of 6 modules) related to the specific substrates of cereal or sugar cane molasses or grape and their related industries.
Candidates must specify at Registration for the Examination which of the elective options they have chosen.

The examination will be based on a single 2 hour paper, comprising 60 Multiple Choice Questions based on both "core" distilling topics and the 3 elective options; the allocation of examination questions per syllabus section is indicated in the Index below (pages 4-9).

The full list of sections in the GCD syllabus is:

**Core Modules**

1. Overview and Glossary
2. Fermentation Theory
3. Fundamentals of Distillation
4. Packaging
5. Utilities – Water
6. Utilities – Effluent
7. Utilities - Energy
8. Distilling and the Environment
9. Plant Cleaning – Chemicals
10. Plant Cleaning – Cleaning Systems
11. Engineering and Maintenance
12. Process Control
13. Quality Control
14. Quality Management Systems (QMS)

## Elective Modules

Raw materials
15. Cereal, 21. Molasses, 27. Grape

Raw Materials Processing
16. Cereal, 22. Molasses, 28. Grape

Fermentation Technology
17. Cereal, 23. Molasses, 29. Grape

Distillation Technology – Batch and Continuous
18. Cereal, 24. Molasses, 30. Grape

Post Distillation Control of Flavour

19. Cereal
    - 19A Maturation and Blending
    - 19B Gin and Vodka Production

25. Molasses
    - 25A Maturation and Blending
    - 25B Gin and Vodka Production

31. Grape
    - 31A Maturation and Blending
    - 31B Gin and Vodka Production

Distillery Co-products
20. Cereal, 26. Molasses, 32. Grape

# GENERAL CERTIFICATE IN DISTILLING - INDEX

## CORE MODULES

9. Plant Cleaning – Chemicals (3 Questions to be answered)

    9.1 Detergents
    9.2 Sterilants
    9.3 Safety

10. Plant Cleaning – Cleaning Systems (3 Questions to be answered)

    10.1 Systems for in-place cleaning (IPC, CIP)
    10.2 Cleaning Cycles
    10.3 Plant design and maintenance for hygiene and efficiency

11. Engineering and Maintenance (2 Questions to be answered)

    11.1 Approaches and tasks
    11.2 Performance improvement

12. Process Control (2 Questions to be answered)

    12.1 Product consistency
    12.2 Quality parameters- process and end product

13. Quality Control (2 Questions to be answered)

    13.1 Flavour evaluation and tasting
    13.2 Microbiological control

14. Quality Management Systems (QMS) (2 Questions to be answered)

    14.1 Descriptions of quality systems
    14.2 Benefits
    14.3 Roles and responsibilities

## END OF CORE MODULES (Total = 40 questions)

# ELECTIVE A – CEREAL

15. Raw Materials (6 Questions to be answered)

15.1 Barley and the malting process
- 15.1.1 Barley; key analytical parameters and approved varieties.
- 15.1.2 Steeping and germination
- 15.1.3 Drying/Kilning; production of Peated malt

15.2 Malt and malt enzymes
- 15.2.1 Malt and its uses, including Green malt
- 15.2.2 Key malt analytical parameters

15.3 Cereals for grain whisky and GNS: maize, wheat, rye
- 15.3.1 Grain properties and basic requirement for selection

15.4 Cultured yeast for cereal wort fermentation
- 15.4.1 Cultured yeasts, yeast strains and their specificity; key analytical parameters
- 15.4.2 Yeast storage and pitching

16. Raw Materials Processing (5 Questions to be answered)

16.1 Milling
- 16.1.1 The purpose of milling; mills for different materials.
- 16.1.2 Appearance of milled malt and grist sieve analyses
- 16.1.3 Safety

16.2 Mashing and wort preparation

**One of the following**: **16.2A or 16.2B** *

**Either:**

16.2A Mashing and wort clarification in malt whisky distilleries
- 16.2A.1 The principles and purposes of mashing.
- 16.2A.2 The principles and purpose of wort separation
- 16.2A.3 Prevention of microbial contamination
- 16.2A.4 Preservation of enzyme activity in wort
- 16.2A.5 Wort properties

**Or**:

16.2B Cereal cooking and mashing for grain whisky/GNS
- 16.2B.1 The purpose and process of cereal cooking; steam supply
- 16.2B.2 Cooling after cooking
- 16.2B.3 The principles and purpose of mashing
- 16.2B.4 Use of bacterial or fungal enzymes (exogenous enzymes)
- 16.2B.5 Wort separation- optional for grain whisky and GNS.

16.3 Wort cooling and aeration

17. Fermentation Technology (1 Question to be answered)

17.1 Progress of fermentation

18. Distillation Technology – Batch or Continuous (4 Questions to be answered)

**One of the following**: **18A or 18B** *

**Either:**

18A Batch (pot) distillation for malt whisky
- 18A.1 Operation of pot stills for malt whisky and similar whiskies.
- 18A.2 Cut points to control product flavour
- 18A.3 Double and triple distillation
- 18A.4 Condensers
- 18A.5 Collection of distillate

**Or:**

18.B Continuous (column) distillation for grain whisky/GNS
- 18B.1 Operation of a single column still and the two column distillation process
- 18B.2 Control of product rectification for flavour
- 18B.3 Removal of fusel oils
- 18B.4 Additional stills for neutral spirit production
- 18B.5 Continuous-batch still arrangements for specific products

19. Post distillation control of flavour (3 Questions to be answered)

**One of the following**: **19A or 19B** *

**Either:**

19A Maturation and Blending
- 19A.1 Role of wood and wood treatment; whisky "finishes"
- 19A.2 Changes occurring in the spirit over the process of maturation
- 19A.3 Blending

**Or:**

19B Gin and vodka production
- 19B.1 Quality of neutral spirit feedstock for gin and vodka
- 19B.2 Botanicals and methods of use for gin production
- 19B.3 Production of vodka from neutral spirit (charcoal filtration)

20. Distillery Co-products (1 Question to be answered)

- 20.1 Range of distillery co-products
- 20.2 Preparation of animal feed
- 20.3 Carbon dioxide

**NOTE:**

*** The examination paper will contain optional questions for these Sections (viz. 16.2A or 16.2B, 18A or 18B, 19A or 19B); candidates can select which of these optional sections to study and answer the appropriate questions.**

## END OF ELECTIVE A – CEREAL (Total = 20 questions)

# ELECTIVE B – SUGAR CANE MOLASSES

21. Raw Materials (3 Questions to be answered)

    21.1 Sources and types of molasses
    21.2 Sugar cane harvesting and processing to molasses; measurement of sugar content
    21.3 Other relevant analysis of molasses

22. Raw Materials Processing (2 Questions to be answered)

    22.1 Pre-treatment, dilution, additions
    22.2 Reduction of microbial count

23. Fermentation Technology (2 Questions to be answered)

    23.1 "Artificial" and "natural" fermentations for dark and light rum and molasses neutral spirit production

24. Distillation Technology (9 Questions to be answered)

    24.1 Operation of batch (pot) stills for heavy rum production
    24.2 Cut points to control product flavour; double and triple distillation
    24.3 Condensers
    24.4 Collection of distillate
    24.5 Continuous (single column) distillation for rum and neutral spirit
    24.6 Operation of the two column distillation process
    24.7 Control of product rectification for flavour
    24.8 Removal of fusel oils
    24.9 Additional stills for neutral spirit production

25. Post distillation control of flavour (3 Questions to be answered)

    **One of the following**: **25A or 25B** *
    **Either:**
    25A Maturation and Blending
        25A.1 Role of wood and wood treatment; finishes and flavourings
        25A.2 Changes occurring in the spirit over the process of maturation
        25A.3 Blending.
    **Or:**
    25B Gin and vodka production
        25B.1 Quality of neutral spirit feedstock for gin and vodka
        25B.2 Botanicals and methods of use for gin production
        25B.3 Production of vodka from neutral spirit (charcoal filtration)

26. Distillery Co-products (1 Question to be answered)

    26.1 Use and disposal of still residues
    26.2 Carbon Dioxide

**NOTE:** * **The examination paper will contain optional questions for these Sections (viz. 25A or 25B); candidates can select which of these optional sections to study and answer the appropriate questions.**

## END OF ELECTIVE B – SUGAR CANE MOLASSES (Total = 20 questions)

# ELECTIVE C – GRAPE

27. Raw Materials (3 Questions to be answered)

    27.1 Source of grapes and wine for spirit production
    27.2 Vine varieties and cultivation of grape vines
    27.3 Grape analysis

28. Raw Materials Processing (2 Questions to be answered)

    28.1 Grape processing to produce Must
    28.2 Additions – Sulphiting and yeast nutrients

29. Fermentation Technology (2 Questions to be answered)

    29.1 Typical fermentation conditions and progress of fermentation
    29.2 Pure culture yeast and "natural fermentations".

30. Distillation Technology (9 Questions to be answered)

    30.1 Operation of batch (pot) stills for cognac and similar brandies
    30.2 Cut points to control product flavour and comparison of double and triple distillation
    30.3 Condensers
    30.4 Collection of distillate
    30.5 Continuous (column) distillation
    30.6 Operation of the two column distillation process
    30.7 Control of product rectification for flavour
    30.8 Removal of fusel oils
    30.9 Additional stills for neutral spirit production

31. Post distillation control of flavour (3 Questions to be answered)

    **One of the following**: **31A or 31B** *
    **Either:**
    31A Maturation and Blending
        31A.1 Role of wood and wood treatment
        31A.2 Changes occurring in the spirit over the process of maturation
        31A.3 Blending.
    **Or:**
    31B Gin and vodka production
        31B.1 Quality of neutral spirit feedstock for gin and vodka
        31B.2 Botanicals and methods of use for gin production
        31B.3 Production of vodka from neutral spirit (charcoal filtration)

32. Distillery Co-products (1 Question to be answered)

    32.1 Range of Distillery Co-products
    32.2 Marc / Pomace
    32.3 Carbon Dioxide

**NOTE: * The examination paper will contain optional questions for these Sections (viz. 31A or 31B); candidates can select which of these optional sections to study and answer the appropriate questions.**

## END OF ELECTIVE C – GRAPE (Total = 20 questions)

# SYLLABUS SECTIONS

# CORE SECTIONS

**Syllabus section 1: Overview and Glossary**

| Syll. Ref. | Topics | Candidates should understand and be able to explain and describe in simple terms, or demonstrate familiarity with: |
|---|---|---|
| 1.1 | Definition of potable spirits | Definitions of the main spirits derived from cereals, molasses and grapes. |
| 1.2 | Characteristics of potable spirits | The range of spirits and their respective styles and characters. |
| 1.3 | Technical Terms | A glossary of the technical terms used in the distilling industry, and their country specific alternatives. |

**Syllabus section 2: Fermentation Theory.**

| Syll. Ref. | Topics | Candidates should understand and be able to explain and describe in simple terms, or demonstrate familiarity with: |
|---|---|---|
| 2.1 | Principles of alcoholic fermentations | The principal fermentable sugars of cereal wort are glucose, maltose and maltotriose; from grapes and molasses, sucrose, glucose and fructose.<br>Conversion of sugars into ethyl alcohol (ethanol) and carbon dioxide ($CO_2$).<br>Relationship between initial sugar concentration and final yield of ethanol.<br>Production of small amounts of by-products of fermentation contribute to the flavour and aroma of the fermented product.<br>Nutritional requirements of distilling yeast, to be provided by wort: sugars, amino acids, mineral salts, vitamins.<br>Changes in concentration of yeast, sugar and alcohol over the course of fermentation.<br>Production of flavour congeners, acids and heat.<br>Ability to interpret graphical data on fermentation. |
| 2.2 | Yeasts and pitching yeast quality | Significance of the name *Saccharomyces cerevisiae.*<br>Structure and appearance of yeast cells.<br>Function of the principal structures of the yeast cell.<br>Types of yeast for distillery fermentation.<br>Mechanism of yeast growth by budding.<br>Significance of yeast growth under aerobic or anaerobic conditions. (fermentation).<br>The requirement for yeast of good viability and vitality and with a low level of infection.<br>The effect of poor yeast quality on the fermentation and subsequent spirit yield. |
| 2.3 | Design, construction and operation of fermentation vessels | Structure of fermentation vessels constructed of wood, steel or stainless steel<br>Operating principles.<br>Importance of sterilization of fermenters, yeast mixing vessel and associated pipe work. |
| 2.4 | Importance of temperature | Importance of "setting temperature" to control maximum temperature during fermentation. |
| 2.5 | Role of other micro-organisms | Influence on pH and positive and negative influences on flavour.<br>The role of *Lactobacillus* in spirit fermentations and its effect on flavour. |
| 2.6 | Safety | The evolution of carbon dioxide from fermentation vessels<br>Hazards associated with $CO_2$.<br>Safety precautions. |

**Syllabus section 3: Fundamentals of Distillation**

| Syll. Ref. | Topics | Candidates should understand and be able to explain and describe in simple terms, or demonstrate familiarity with: |
|---|---|---|
| 3.1 | Theory of distillation | Liquid/vapour equilibrium – understanding of the graphic model.<br>Volatility of components.<br>Increase in the more volatile component.<br>Reflux, reflux ratio and factors affecting reflux. |
| 3.2 | Basic concepts of batch and continuous distillation | Meaning of the terms “batch” and “continuous” distillation.<br>Flow diagram for both processes. |
| 3.3 | The role of copper | Use in stills and condensers to promote esters and/or remove sulphur compounds.<br>Other reasons to use copper: malleability, conductivity, corrosion resistance, soldering. |
| 3.4 | Safety | Flammability and explosion risks of alcohol.<br>Fire and explosion dangers at stills, in storage and operations involving spirits.<br>Essential precautions.<br>Safety and emergency procedures. |

**Syllabus section 4: Packaging**

| Syll. Ref. | Topics | Candidates should understand and be able to explain and describe in simple terms, or demonstrate familiarity with: |
|---|---|---|
| 4.1 | Spirit preparation for packaging | The process and equipment used to:-<br>reduce the spirit to bottling strength -see also sections 5.1 and 12.2 for reduction water quality;<br>adjust the colour to specification;<br>chill filtration to remove haze and floc;<br>attemporation to filling temperature. |
| 4.2 | Unit processes of packaging | Control of in-coming raw materials.<br>Processes of bottle rinsing, filling, capping/sealing, labeling, inspection, packing, case sealing and palletization. |
| 4.3 | Identification and protection of packages and the detection and prevention of fraud | Lot marking, bar coding and date stamping.<br>Use of secondary and tertiary packaging for product protection.<br>Use of tamper evident seals, non-refillable fitments and tax strips.<br>Analysis of components specific to a brand. |

**Syllabus section 5: Utilities – Water**

| Syll. Ref. | Topics | Candidates should understand and be able to explain and describe in simple terms, or demonstrate familiarity with: |
|---|---|---|
| 5.1 | Quality requirements of water at all stages of production | Sources of water: borehole, surface, municipal/ public.<br>Categories of water: process water, utility water, cooling water and their specification.<br>Reuse, recovery and conservation considerations in the use of water.<br>Reliability and consistency of supply.<br>Appearance, odour and taste.<br>Dissolved salts and their importance.<br>Microbiological quality of the water.<br>Temperature for cooling purposes. |
| 5.2 | Water treatment | Legal restrictions that may forbid treatment of process water e.g. Scotch Whisky Act.<br>Appropriate sand and charcoal filtration, reverse osmosis, ion exchange and sterilization for process, utility and cooling waters.<br>Salt additions.<br>Boiler feed water treatment.<br>Prevention of *Legionella* infection in cooling towers. |

**Syllabus section 6: Utilities – Effluent**

| Syll. Ref. | Topics | Candidates should understand and be able to explain and describe in simple terms, or demonstrate familiarity with: |
|---|---|---|
| 6.1 | Sources of effluent and measurement | Measurement of effluent volume and strength – biological and chemical oxygen demand, suspended solids, pH and temperature. |
| 6.2 | Effluent treatment systems and control strategies. | Aerobic and anaerobic systems and their relevant application.<br>Final treatment and copper removal.<br>Temperature and pH considerations for consented discharge to sewer.<br>Government controls on discharge to the environment and to public sewer.<br>Factors affecting decision on in-house or off-site treatment.<br>Charging systems and their influence on above decision. |

**Syllabus section 7: Utilities – Energy**

| Syll. Ref. | Topics | Candidates should understand and be able to explain and describe in simple terms, or demonstrate familiarity with: |
|---|---|---|
| 7.1 | Steam quality - – direct and indirect use | Main uses of steam in distilling.<br>Difference between direct and indirect use of steam; implications for steam quality.<br>Direct: cleaning/sterilisation of plant, direct injection to stripper column of continuous still.<br>Indirect: operation of pot stills and reboilers, production of effluent concentrates. |
| 7.2 | Steam safety | The potential dangers of steam and steam distribution systems. The importance of slowly removing condensate from systems on start-up. |

**Syllabus section 8: Distilling and the Environment**

| Syll. Ref. | Topics | Candidates should understand and be able to explain and describe in simple terms, or demonstrate familiarity with: |
|---|---|---|
| 8.1 | Sustainability and climate change. | The concept of a sustainable industry.<br>The role of carbon dioxide – the carbon cycle.<br>Sources of carbon dioxide emissions. |
| 8.2 | Energy and water conservation | The principal energy and water consuming activities in a distillery.<br>Typical energy and water reduction opportunities.<br>Preheating of still charges.<br>Still Condenser layouts and their efficiency.<br>Hot water recovery systems. |
| 8.3 | Packaging waste | The impact of packaging waste on household (consumer) recycling.<br>Strategies to minimize packaging material and encourage recycling. |

**Syllabus section 9: Plant Cleaning – Chemicals (detergents /sterilants).**

| Syll. Ref. | Topics | Candidates should understand and be able to explain and describe in simple terms, or demonstrate familiarity with: |
|---|---|---|
| 9.1 | Detergents | Types of detergent (alkali or acid).<br>The constituents of detergents.<br>The individual functions of the constituents.<br>Criteria for choice of detergent for an application.<br>Considerations for the use of hot detergent cleaning. |
| 9.2 | Sterilants | Types of sterilant as defined by the active agent.<br>Criteria for choice of sterilant for an application.<br>The effect of sterilant residues on beer quality.<br>Uses of steam and hot water as sterilants<br>Typical exposure times necessary. |
| 9.3 | Safety | The hazards associated with chemical cleaning and sterilizing agents.<br>Good practices for the storage of chemicals.<br>Use of personal protective clothing.<br>Procedures in case of accidental spillage or discharge of chemicals. |

**Syllabus section 10: Plant Cleaning – Cleaning Systems.**

| Syll. Ref. | Topics | Candidates should understand and be able to explain and describe in simple terms, or demonstrate familiarity with: |
|---|---|---|
| 10.1 | Systems for in-place cleaning (IPC / CIP) | The general differences between single use and recovery systems.<br>The types of cleaning head used and reasons for their choice.<br>The operating principles and diagrammatic representation of CIP systems. |
| 10.2 | Cleaning cycles | Typical cleaning programs and cycle times.<br>The functions of the cleaning cycle stages. |
| 10.3 | Plant design and maintenance for hygiene and efficiency | Design features that minimize soil accumulation in vessels and pipelines.<br>Design features that facilitate vessel and pipeline cleaning using a CIP system.<br>Design features which promote a hygienic working environment. |

**Syllabus section 11: Engineering and Maintenance.**

| Syll. Ref. | Topics | Candidates should understand and be able to explain and describe in simple terms, or demonstrate familiarity with: |
|---|---|---|
| 11.1 | Approaches and tasks | The business motives for an effective maintenance system.<br>The features, advantages, disadvantages and applications of:<br>- No maintenance,<br>- Corrective Maintenance ,<br>- Preventative Maintenance.<br>The relationship between corrective and preventative maintenance.<br>The contribution of routine maintenance tasks to plant safety, reliability, quality, economics and environmental impact. |
| 11.2 | Performance improvement | The key features of the following performance orientated maintenance systems:<br>- Reliability centred maintenance (RCM),<br>- Total productive maintenance (TPM),<br>- Workplace Organisation (5s),<br>- Condition Monitoring. |

**Syllabus section 12: Process control.**

| Syll. Ref. | Topics | Candidates should understand and be able to explain and describe in simple terms, or demonstrate familiarity with: |
|---|---|---|
| 12.1 | Product consistency | The variable nature of natural ingredients.<br>The influence of process parameters on final product.<br>The principles of monitoring and adjustment to achieve product consistency.The concept of 'trueness to type.'<br>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.<br>Spirit :alcohol, colour, sensory, chill haze analysis<br>Neutral spirit: diacetyl and methanol<br>Due diligence: ATNC, Ethyl Carbamate (EC), pesticide and fungicide residues, copper.<br>Reducing water: metals – Cu and Fe.<br>Factors affecting these parameters during production.<br>The purpose of a specification. The concepts of tolerance and range for specification parameter values.<br>Typical specifications which differentiate product types.<br>Typical process specification ranges, especially those requiring periodic adjustment to achieve product consistency.<br>Typical applications for in-line and on-line instrumental process control. |

**Syllabus section 13: Quality Control**

| Syll. Ref. | Topics | Candidates should understand and be able to explain and describe in simple terms, or demonstrate familiarity with: |
|---|---|---|
| 13.1 | Flavour evaluation and tasting | The reasons for adopting industry standard descriptors for aroma and taste.<br>The more commonly used descriptors of the flavour wheel.<br>Taste training procedures.<br>The three-glass test – statistical significance rating.<br>Flavour profiling.<br>Trueness to type panel tasting.<br>Common faults / contamination that may be detected by tasting during production operations. |
| 13.2 | Microbiological control | Health risks and control of *Legionella pneumophilia* in cooling water towers and other warm service waters.<br>Positive and negative aspects of lactic acid bacteria in a distillery.<br>Water-borne coliform (*Esherichia coli and Enterobacteria*): the implications of their presence.<br>Microbiological control of yeast handling systems.<br>Microbiological control of reduction and process waters. |

**Syllabus section 14: Quality Management Systems (QMS).**

| Syll. Ref. | Topics | Candidates should understand and be able to explain and describe in simple terms, or demonstrate familiarity with: |
|---|---|---|
| 14.1 | Describing a quality system | The key features of a quality system *viz.*:<br>- written specifications<br>- written procedures<br>- monitoring of performance<br>- Corrective actions<br>- Auditing<br>- Regular reviews for improvement. |
| 14.2 | Benefits | The business benefits of an effective quality management system. |
| 14.3 | Roles and responsibilities | The impact of individual actions on product and service quality.<br>The control of documentation.<br>The maintenance of conformity. |

## END OF CORE SECTIONS

# ELECTIVE A – CEREAL

Candidates will be expected to describe, simply but accurately, the key biological, chemical and engineering principles that underpin the production of malt and grain new make spirit and whiskies, grain neutral spirit, gin and vodka.

## Syllabus section 15: Raw materials

### Syllabus section 15.1: Barley and the malting process

| ***Syll. Ref.*** | ***Topics*** | ***Candidates should understand and be able to explain in simple terms,* or demonstrate familiarity with:** |
|---|---|---|
| 15.1.1 | Barley; key analytical parameters and approved varieties. | The structure of barley grain and the importance of the embryo, endosperm and husk.<br>The quality requirements for malting barley and the reasons why the distilling industry has these requirements for malt and grain distilling – particularly: viability, no splits, no infestation, total nitrogen, % screenings < 2.5 mm, 1000 corn weight, ethyl carbamate (EC) precursors. |
| 15.1.2. | Steeping and germination. | The technology of malting and the influence of each stage of the process on malt quality. Requirement for clean humidified air |
| 15.1.3. | Drying/Kilning And production of Peated malt | The technology of kilning and the reasons for the drying temperatures and air flows at different moisture contents during the kilning process. Preservation of malt enzymes. What peat is, how it is processed and how burning of peat contributes phenolic flavours to malt. |

### Syllabus section 15.2: Malt and malt enzymes

| ***Syll. Ref*** | ***Topics*** | ***Candidates should understand and be able to explain in simple terms,* or demonstrate familiarity with:** |
|---|---|---|
| 15.2.1 | Malt and its uses, Including green malt. | The importance of malt to mashing and fermentation, particularly for yeast nutrients, a source of enzymes and as a filter medium for wort.<br>The advantages and disadvantages of the use of green malt in grain whisky distilleries. |
| 15.2.2 | Key malt analytical parameters. | The reasons for setting specific values for: moisture, extract, fermentability, modification, enzymes, nitroso compounds, ethyl carbamate (EC) precursors potential. |

**Syllabus section 15.3: Cereals for grain whisky and GNS: maize, wheat, rye.**

| ***Syll. Ref.*** | ***Topics*** | **Candidates should understand and be able to explain and describe in simple terms, or demonstrate familiarity with:** |
|---|---|---|
| 15.3.1 | Grain properties and selection | The structure of these cereal grains and their importance as sources of starch for the production of fermentable sugars. |
| 15.3.2. | Basic requirements | Key analytical parameters for wheat, maize and rye particularly:<br>moisture, extract, hardness, bulk density. |

**Syllabus section 15.4: Enzymes for GNS production.**

| ***Syll. Ref.*** | ***Topics*** | **Candidates should understand and be able to explain and describe in simple terms, or demonstrate familiarity with:** |
|---|---|---|
| 15.4.1 | Selection and properties of exogenous enzymes | The sources and uses of exogenous enzyme activities for the production of additional fermentable sugars from starch. |

**Syllabus section 15.5: Cultured yeast for cereal wort fermentation**

| | ***Topics*** | **Candidates should understand and be able to explain and describe in simple terms, or demonstrate familiarity with:** |
|---|---|---|
| 15.5.1 | Cultured yeasts. Yeast strains and their specificity. Key analytical parameters | The nature of cultured yeast and its role in the industrial fermentation of cereal wort.<br>Which strains and types of yeast are allowed and their specificity for cereal wort sugars.<br>The importance of high viability and the relevance of moisture content of cream, pressed and dried yeast. |
| 15.5.2 | Yeast storage and pitching | The requirement for cold storage, especially of pressed and cream yeast, to preserve viability.<br>The necessity for the preparation of correct concentration of yeast from cream, pressed or dried yeast without contamination or loss of viability. |

# Syllabus section 16: Raw materials processing

**(NOTE: Choose EITHER 16.2 A OR 16.2 B)**

## Syllabus section 16.1: Milling

| ***Syll. Ref.*** | ***Topics*** | **Candidates should understand and be able to explain and describe in simple terms, or demonstrate familiarity with:** |
|---|---|---|
| 16.1.1 | The purpose of milling.<br>Mills for different materials. | The purpose and principles of milling (*size reduction*) for malt and grain distilling.<br>The need for specific types of mill for kilned and green malt, and for unmalted cereal. |
| 16.1.2 | Appearance of milled malt and grist sieve analyses | The appearance of crushed malt.<br>The significance of crushed malt grist analysis and the problems associated with grinds that are too fine or too coarse. |
| 16.1.3. | Safety | Health and safety hazards associated with cereal dust, and the necessary personal protection and plant safety measures |

**Syllabus section 16.2: Mashing and wort preparation**

## ONE ONLY OF THE FOLLOWING SECTIONS: 16.2A OR 16.2B

**EITHER:**

**Section 16.2A: Mashing and wort clarification in malt whisky distilleries**

| ***Syll. Ref.*** | ***Topics*** | **Candidates should understand and be able to explain and describe in simple terms, or demonstrate familiarity with:** |
|---|---|---|
| 16.2A.1 | The principles and purpose of mashing. | The principles of mashing, especially the importance of:<br>temperature, malt enzymes, water ratio (mash thickness) and time.<br>Prior gelatinisation of starch and starch conversion, in qualitative terms.<br>The origin of the fermentable sugars of wort and their significance. |
| 16.2A.2 | The principles and purpose of wort separation. | The purpose and practice of separating malt distillery wort from the (spent) grains and the operation of methods for achieving this:<br>traditional mash tun, lauter tun or mash filter. |
| 16.2A.3 | Prevention of microbial contamination | The importance of rapid wort transfer |
| 16.2A.4 | Preservation of enzyme activity in the wort | The importance of preservation of enzymes for activity in the washback |
| 16.2A.5 | Wort properties | The important wort quality parameters:<br>specific gravity, fermentability, pH (and wort clarity in malt distilleries). |

**OR:**

**Section 16.2B: Cereal cooking and mashing for grain whisky/GNS**

| ***Syll. Ref.*** | ***Topics*** | **Candidates should understand and be able to explain and describe in simple terms, or demonstrate familiarity with:** |
|---|---|---|
| 16.2B.1 | The purpose and process of cereal cooking; steam supply. | The purpose of cereal cooking: gelatinisation of the starch of wheat or maize prior to mashing.<br>The batch process of cereal cooking: **either** at atmospheric pressure and 100°C, **or** by pressure cooking, e.g. at 3 bar (145°C). **Alternatively**, the process of continuous cooking under pressure.<br>The importance of steam quality, to prevent off-flavour from steam injected into the cereal mash. |
| 16.2B.2 | Cooling after cooking | A system of cooling to mashing temperature by release of pressure and evaporation of steam, heat exchanger, addition of cold water or a combination of these methods. |
| 16.2B.3 | The principles and purpose of mashing | The principles of mashing, especially the importance of: temperature, enzymes, water ratio (mash thickness) and time.<br>The origin of the fermentable sugars of wort, and their significance |
| 16.2B.4 | The use of bacterial or fungal enzymes (exogenous enzymes) | The reasons why exogenous enzymes are permitted to prepare wort for neutral spirit/gin/ vodka production but **not** for Scotch whisky wort. |
| 16.2B.5 | Wort separation - optional for grain whisky and GNS | The advantages and disadvantages of separating wort from spent grains in grain distilleries. |

**Syllabus section 16.3: Wort cooling and aeration**

| ***Syll. Ref.*** | ***Topics*** | **Candidates should understand and be able to explain and describe in simple terms, or demonstrate familiarity with:** |
|---|---|---|
| 16.3.1 | Cooling and aeration | The purpose and practice of wort cooling.<br>Detail of methods of wort cooling (e.g. "paraflow" heat exchanger or open cooler).<br>The requirement of yeast for dissolved oxygen at the start of fermentation.<br>The process (achievement) of wort aeration and/or oxygenation. |

## Syllabus section 17: Fermentation Technology.

| **Syll. Ref.** | **Topics** | **Candidates should understand and be able to explain and describe in simple terms, or demonstrate familiarity with:** |
|---|---|---|
| 17.1 | Progress of fermentation | Procedures to control and monitor fermentation<br>Significance of specific gravity and pH measurements during fermentation. |

## Syllabus section 18: Distillation Technology – Batch or Continuous

## ONE OF THE FOLLOWING SECTIONS: 18A OR 18B

**EITHER:**

### Section 18A: Batch (pot) distillation for malt whisky

| Syll. Ref. | Topics | Candidates should understand and be able to explain and describe in simple terms, or demonstrate familiarity with: |
|---|---|---|
| 18A.1 | Operation of pot stills for malt whisky and similar whiskies. | The theory of vapour/liquid equilibrium, the increase in concentration of the more volatile component, reflux and reflux ratio. Plotting and interpreting simple graphical data on distillation.<br>The double distillation process:<br>Basic construction and design of stills and their operation.<br>Inputs and outputs to the stills – volumes and strengths (abv) of all streams, including still residues.<br>Composition and pre-heating of the charges.<br>Avoiding foul wash distillations and blank spirit distillations.<br>Effect of speed of distillation, reflux and still design on alcohol concentration and congeners. |
| 18A.2 | Cut points to control flavour | Reflux and the distillation of flavour congeners,<br>The cut points and fractions in a batch spirit distillation.<br>How the cut points are set.<br>Effect of moving cut points on efficiency and product quality – heads, spirit and tails. |
| 18A.3 | Double and triple distillation | Reasons for using double and triple distillation<br>Process flow for double and for triple distillation |
| 18A.4 | Condensers | The design and operation of condensers – worm tub and shell and tube.<br>Energy efficiency and effect on spirit quality of different condensers<br>Split cooling loads – latent heat and sensible heat (spirit cooler) |
| 18A.5 | Collection of distillate | The design and operation of the wash and spirit safes.<br>Procedures and process flows for the collection of low wines, spirit and foreshots and feints (heads and tails).<br>Foreshots and feints receiver design and operation.<br>Balanced and unbalanced operation. |

**OR:**

**Section 18B: Continuous (column) distillation for grain whisky and GNS**

| Syll. Ref. | Topics | Candidates should understand and be able to explain and describe in simple terms, or demonstrate familiarity with: |
|---|---|---|
| 18B.1 | Operation of a single column still and the two column distillation process | Layout and operation of a single column still<br>Feed position and feed condition<br>Top and bottom products<br>Reboiler or steam injection.<br>Overhead condenser<br>Design and operation of a two still system - Coffey still or Beer Stripper/Rectifier set-up<br>Composition and preheating of the feed.<br>The requirement for aeration of the wash and/or feints to destroy ethyl carbamate precursors<br>Condensing and cooling systems.<br>Start-up, shutdown and control of the columns<br>Steam quality requirements. |
| 18B.2 | Control of product rectification for flavour | The distribution of flavour congeners in the rectifier.<br>Limiting product strength to produce a self-flavoured product.<br>Collection at higher strength to reduce congener content.<br>Re-rectification to reduce/remove impurities.<br>Recovery and recycling of hot and cold feints.<br>Material balances over the still/s. |
| 18B.3 | Removal of fusel oils | Composition of "fusel oil"<br>Reasons for removal from the still system.<br>Methods for the removal of fusel oils from the appropriate level of the rectifier.<br>Recovery as a co-product and basic principles of operation of fusel oil decanter and fusel oil still |
| 18B.4 | Additional stills for neutral spirit production | The design and operation of continuous stills for GNS production. Function and sequence of the stills.<br>Extractive (hydroselective) distillation and re-rectification to reduce congeners.<br>Heads purifying (acetaldehyde) column.<br>Methanol reduction column.<br>Recovery and recycling of hot and cold feints<br>Material balances over the still/s<br>Condensing and cooling systems<br>Steam quality requirements |
| 18B.5 | Continuous-batch still arrangements for specific products | Bourbon production with continuous column and doubler. |

## Syllabus Section 19: Post distillation control of flavour

## ONE OF THE FOLLOWING SECTIONS: 19A OR 19B

**EITHER:**

**Section 19A: Maturation and Blending.**

| Syll. Ref. | Topics | Candidates should understand and be able to explain and describe in simple terms, or demonstrate familiarity with: |
|---|---|---|
| 19A.1 | Role of wood and wood treatment; whisky "finishes" | Main types of cask wood: American and European oak<br>Reasons for use of these woods: strength, no leakage, contribution to flavour<br>Surface/volume ratio of different types of cask<br>Storage conditions, especially temperature and humidity<br>Effect of atmospheric oxygen.<br>Use of treated cask, or casks used previously to hold another beverage (e.g. port, sherry, wine etc.) to produce whisky "finishes". |
| 19A.2 | Changes occurring in the spirit over the process of maturation | Characteristics of new and mature spirit<br>Immature characters to be removed<br>Desirable mature characteristics<br>Evaporation (loss of high-volatile congeners)<br>Absorption into char layer of wood surface<br>Extraction of colour and flavour congeners, e.g. tannins, from wood<br>Reactions within the maturing spirit, e.g. oxidation, formation of esters |
| 19A.3 | Blending | 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.<br>Organisation of stock.<br>Choice of spirits, emptying casks, filtration, mixing, the importance of tasting and/or chemical analysis at critical points in the process |

**OR:**

**Syllabus section 19B: Gin and vodka production**

| Syll. Ref. | Topics | Candidates should understand and be able to explain and describe in simple terms, or demonstrate familiarity with: |
|---|---|---|
| 19B.1 | Quality of neutral spirit feedstock for gin and vodka.<br>Exogenous enzymes in GNS production. | Quality standards for gin and vodka production.<br><br>How bacterial and fungal enzymes are used for the hydrolysis of cereal starch. |
| 19B.2 | Botanicals and methods of use for gin production | The principal plant materials used for the flavouring of gin.<br>How essential oils are preserved, and how and why botanicals are used in gin distillation.<br>Harvesting, drying, storage and use of botanicals in gin making<br>Principles of distillation: cut points for heads, gin and tails<br>Production of flavouring extracts by solvent extraction or distillation<br>Quality requirements and principles of sensory evaluation of gin. |
| 19B.3 | Production of vodka from neutral spirit (Charcoal filtration) | Requirement for removal of flavour congeners by redistillation. Principles of hydro-selective distillation<br>Quality requirements and principles of sensory evaluation of vodka.<br>Carbon treatment process |

## Syllabus Section 20: Distillery Co-products

| Syll. Ref. | Topics | Candidates should understand and be able to explain and describe in simple terms, or demonstrate familiarity with: |
|---|---|---|
| 20.1 | Range of distillery co-products | Spent grains (draff) from malt distillery mashing<br>Carbon dioxide from grain distillery fermentation<br>Pot ale from malt whisky wash distillation<br>Spent wash from continuous distillation<br>"Fusel oil" from continuous distillation<br>Awareness of other waste streams of no commercial value: malt distillery $CO_2$, spent lees |
| 20.2 | Preparation of animal feed | Significance of seasonal demand.<br>De-watering of spent grains (draff).<br>Concentration of pot ale to syrup: basic principles of operation of a natural circulation evaporator.<br>Separation of solid and liquid phases of spent wash for de-watering and evaporation respectively, for eventual mixing as "dark grains".<br>Energy-saving implications of multiple-effect evaporation. |
| 20.3 | Carbon dioxide | Uses of liquid and solid $CO_2$<br>Requirement for purification by scrubber and catalyst columns before chilling and compressing $CO_2$ |

## END OF ELECTIVE A - CEREAL

# ELECTIVE B – SUGAR CANE MOLASSES

Candidates will be expected to describe, simply but accurately, the key biological, chemical and engineering principles that underpin the production of rums, neutral spirit, gin and vodka

## Syllabus section 21. Raw materials

| ***Syll. Ref.*** | ***Topics*** | ***Candidates should understand and be able to explain in simple terms,* or demonstrate familiarity with:** |
|---|---|---|
| 21.1 | Sources and types of molasses | Origins of molasses: sugar cane.<br>Variability with region of production, season and from different sugar mills, and the effect of sugar refining on molasses quality.<br>Standard molasses, first, second and blackstrap molasses and high test molasses |
| 21.2 | Harvesting and processing to molasses; measurement of sugar content | Harvesting of the sugar cane crop and processing to produce sugar, with the by-product of molasses for the production of distilled beverages.<br>Use of the Brix hydrometer. Degrees Balling<br>Relationship between yield of sugar crystals and quality of molasses.<br>Measurement of sugar content: sugar % ($^{w}/_{w}$) and degrees Brix ($^{o}$Brix). |
| 21.3 | Relevant analysis of molasses | Flavour, colour, total solids, dry matter content.<br>Components important for fermentation: fermentable sugars, minerals, available nitrogen, vitamins and a low level of substances toxic to yeast. |

## Syllabus section 22: Raw materials processing

| ***Syll. Ref.*** | ***Topics*** | **Candidates should understand and be able to explain and describe in simple terms, or demonstrate familiarity with:** |
|---|---|---|
| 22.1 | Pre-treatment, dilution and additions | Removal of solids and scale by centrifugation<br>Adjustment to the required sugar content ($^{o}$Brix) for fermentation.<br>Acid addition to adjust acidity level/pH.<br>Yeast nutrient addition – di-ammonium phosphate.<br>Addition of stillage – backset or dunder |
| 22.2 | Reduction of microbial count. | Use of heat treatment (pasteurisation or sterilisation) and/or antibiotics to reduce microbial count. |

## Syllabus section 23: Fermentation Technology.

| Syll. Ref. | Topics | Candidates should understand and be able to explain and describe in simple terms, or demonstrate familiarity with: |
|---|---|---|
| 23.1 | "Artificial" and "natural" fermentations for dark and light rums and molasses neutral spirit production | Procedures to control and monitor fermentation<br>Significance of specific gravity and pH measurements during fermentation<br>Different types of yeast: cake, cream and dried<br>Procedures for pitching (inoculating) of wort with these types of yeast.<br>Late fermentation by yeast and bacteria from dunder for heavy rum production<br>Significance of temperature of wort at pitching |

## Syllabus section 24: Distillation Technology – Batch and Continuous

| Syll.Ref. | Topics | Candidates should understand and be able to explain and describe in simple terms, or demonstrate familiarity with: |
|---|---|---|
| 24.1 | Operation of batch stills (pot) for heavy rum production. | The theory of vapour/liquid equilibrium, the increase in concentration of the more volatile component, reflux and reflux ratio.<br>Plotting and interpreting simple graphical data on distillation.<br>Design of the stills, including batch pot and column arrangement for heavy type rum production.<br>Sequential batch – beer, low wine, high wine – stills for rum. Stills acting as total condensers.<br>Composition and pre-heating of the charges<br>Reflux and the distillation of flavour congeners,<br>Material balances over wash and spirit distillations – volumes and alcohol content (ABV) of all streams, including still residues.<br>The design and operation of condensers – worm tubs (serpentines), shell and tube, including spirit coolers<br>The design of the spirit safe and procedures for the collection of low wines, (high wines) spirit, heads and tails. |
| 24.2 | Cut points to control flavour. Double and triple distillation | Reflux and the distillation of flavour congeners,<br>Material balances over wash and spirit distillations – volumes and alcohol content (ABV) of all streams, including still residues.<br>Limiting product strength to less than 96% abv to retain raw material character.<br>Reasons for using double and triple distillation<br>Process flow for double and for triple distillation. |

| | | |
|---|---|---|
| 24.3 | Condensers | The design and operation of condensers – worm tub (serpentines) and shell and tube.<br>Energy efficiency and effect on spirit quality of different condensers. Split cooling loads – latent heat and sensible heat (spirit cooler). |
| 24.4 | Collection of distillate | The design of the spirit safe and procedures for the collection of low wines, spirit and foreshots and feints. |
| 24.5 | Continuous (single column) distillation for rum and neutral spirit production | Layout and operation of a single column still<br>Feed position and feed condition<br>Top and bottom products<br>Reboiler or steam injection.<br>Overhead condenser. |
| 24.6 | Operation of the two column distillation process | The design and operation of column still set-ups:<br>a. Two column (Coffey type) still<br>b. Barbet still and concentrator<br>Composition and preheating of the feed.<br>The distribution of flavour congeners in the rectifier.<br>Methods for the removal of fusel oils from the appropriate level of the rectifier and its recovery as a co-product.<br>Recovery and recycling streams for heads and tails.<br>Material balances over the still/s<br>Condensing and cooling systems.<br>Steam quality requirements |
| 24.7 | Control of product rectification for flavour | The distribution of flavour congeners in the rectifier. Limiting product strength to produce a self-flavoured product. Collection at higher strength to reduce congener content. Re-rectification to reduce/remove impurities. Recovery and recycling of hot and cold feints. Material balances over the still/s. |
| 24.8 | Removal of fusel oils | Composition of "fusel oil"<br>Reasons for removal from the still system. Methods for the removal of fusel oils from the appropriate level of the rectifier.<br>Recovery as a co-product and basic principles of operation of fusel oil decanter and fusel oil still |
| 24.9 | Additional stills for neutral spirit production | The design and operation of continuous stills for NS production. Function and sequence of the stills and distillate at 96% abv or greater.<br>Extractive (hydroselective) distillation and re-rectification to reduce congeners.<br>Methods for removal of propanols, acetaldehyde and methanol.Heads purifying (acetaldehyde) column.<br>Methanol reduction column.<br>Recovery and recycling of hot and cold feints<br>Material balances over the still/s<br>Condensing and cooling systems<br>Steam quality requirements |

## Syllabus Section 25: Post distillation control of flavour

## ONE OF THE FOLLOWING SECTIONS: 25A OR 25B

**EITHER:**

**Section 25A: Maturation and Blending.**

| Syll. Ref. | Topics | Candidates should understand and be able to explain and describe in simple terms, or demonstrate familiarity with: |
|---|---|---|
| 25A.1 | Role of wood and wood treatment; finishes and flavourings | Main types of cask wood: American and European oak<br>Reasons for use of these woods: spirit strength (typically 70% abv), no leakage, contribution to flavour.<br>Surface/volume ratio of different types of cask<br>Storage conditions, especially temperature and humidity<br>Effect of atmospheric oxygen.<br>Use of caramel in rum production.<br>Use of flavours and essences to produce rum based products. |
| 25A.2 | Changes occurring in the spirit over the process of maturation | Characteristics of new and mature spirit<br>Immature characters to be removed<br>Desirable mature characteristics<br>Evaporation (loss of high-volatile congeners)<br>Absorption into char layer of wood surface<br>Extraction of colour and flavour congeners, e.g. tannins, from wood<br>Reactions within the maturing spirit, e.g. oxidation, formation of esters |
| 25A.3 | Blending | 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.<br>Organisation of stock.<br>Choice of spirits, emptying casks, filtration, mixing, the importance of tasting and/or chemical analysis at critical points in the process. |

**OR:**

**Syllabus section 25B: Gin and vodka production**

| Syll. Ref. | Topics | Candidates should understand and be able to explain and describe in simple terms, or demonstrate familiarity with: |
|---|---|---|
| 25B.1 | Quality of neutral spirit feedstock for gin and vodka | Quality standards for gin and vodka production |
| 25B.2 | Botanicals and methods of use for gin production | The principal plant materials used for the flavouring of gin.<br>How essential oils are preserved, and how and why botanicals are used in gin distillation.<br>Harvesting, drying, storage and use of botanicals in gin making<br>Principles of distillation: cut points for heads, gin and tails<br>Production of flavouring extracts by solvent extraction or distillation<br>Quality requirements and principles of sensory evaluation of gin. |
| 25B.3 | Production of vodka from neutral spirit (charcoal filtration). | Requirement for removal of flavour congeners by redistillation.<br>Principles of hydro-selective distillation.<br>Quality requirements and principles of sensory evaluation of vodka.<br>Carbon treatment process. |

## Syllabus Section 26: Distillery Co-products

| Syll. Ref. | Topics | Candidates should understand and be able to explain and describe in simple terms, or demonstrate familiarity with: |
|---|---|---|
| 26.1 | Use and disposal of still residues | Concentration of pot ale to syrup: basic principles of operation of a natural circulation evaporator<br>Energy-saving implications of multiple-effect evaporation |
| 26.2 | Carbon dioxide | Uses of liquid and solid $CO_2$<br>Requirement for purification by scrubber and catalyst columns before chilling and compressing $CO_2$ |

# END OF ELECTIVE B – SUGAR CANE MOLASSES

# ELECTIVE C – GRAPE

Candidates will be expected to describe, simply but accurately, the key biological, chemical and engineering principles that underpin the production of grape brandy, grape neutral spirit, gin and vodka.

## Syllabus section 27: Raw Materials

| ***Syll. Ref.*** | ***Topics*** | ***Candidates should understand and be able to explain in simple terms,* or demonstrate familiarity with:** |
|---|---|---|
| 27.1 | Source of grapes and wine for spirit production | Influence on the quality of the final product of grape varieties, location of vineyard, soil type, climate and weather in each season. |
| 27.2 | Vine varieties and cultivation of grape vines | Selection of vines for distilled spirits. Regional restrictions and legal requirements.<br>Essential tasks of viticulture throughout the year. |
| 27.3 | Grape Analysis | Analyses that determine when to pick the grapes. |

## Syllabus section 28: Raw materials processing

| ***Syll. Ref.*** | ***Topics*** | **Candidates should understand and be able to explain and describe in simple terms, or demonstrate familiarity with:** |
|---|---|---|
| 28.1 | Grape processing to produce must | Choice of time of harvesting for yield and quality. Optimising the sugar content.<br>Pressing method and its effect on quality. Short time lapse before gentle pressing to extract the must.<br>Influence of composition and treatment of must on quality of wine.<br>Reasons and effects of solids removal. |
| 28.2 | Additions: sulphiting and yeast nutrients. | Sulphiting of the must as a preparation for selected pure culture fermentation.<br>Addition of yeast nutrients (such as ammonium salts and vitamins). How solid removal might affect yeast nutrients. The effect of inadequate yeast nutrients on fermentations and quality. |

## Syllabus section 29: Fermentation Technology.

| Syll. Ref. | Topics | Candidates should understand and be able to explain and describe in simple terms, or demonstrate familiarity with: |
|---|---|---|
| 29.1 | Typical fermentation conditions and progress of fermentation | Reasons for selection of fermentation conditions for brandy wine, e.g. low temperature, low pH, high specific gravity.<br>Procedures to control and monitor fermentation<br>Significance of specific gravity and pH measurements during fermentation. |
| 29.2 | Pure culture yeast and “natural” fermentations | Selection of the pure culture: e.g. from another winery, and propagation of a pure yeast culture.<br>Use of dried yeast and re-hydration methods.<br>Procedures for pitching (inoculating) of wort with these types of yeast.<br>Advantages and disadvantages of spontaneous (“natural”)fermentation.<br>Initial and secondary phases of fermentation. |

## Syllabus section 30: Distillation Technology – Batch and Continuous

| Syll.Ref. | Topics | Candidates should understand and be able to explain and describe in simple terms, or demonstrate familiarity with: |
|---|---|---|
| 30.1 | Operation of batch (pot) stills for cognac and similar brandies. | The theory of vapour/liquid equilibrium, the increase in concentration of the more volatile component, reflux and reflux ratio.<br>Plotting and interpreting simple graphical data on distillation.<br>The single and double distillation process:<br>Design of the stills: simple, Charantais alembic and including stills with plates (trays).<br>Composition and pre-heating of the charges<br>Reflux and the distillation of flavour congeners,<br>Material balances over distillations – volumes and alcohol content (ABV) of all streams, including still residues.<br>The design and operation of condensers – worm tub (serpentine) and shell and tube, including spirit coolers<br>The design of the spirit safe and procedures for the collection of low wines, spirit, heads and tails. |
| 30.2 | Cut points to control flavour and comparison of double and triple distillation | Reflux and the distillation of flavour congeners,<br>Material balances over wash and spirit distillations – volumes and alcohol content (ABV) of all streams, including still residues.<br>Reasons for using double and triple distillation<br>Process flow for double and for triple distillation. |

| | | |
|---|---|---|
| 30.3 | Condensers | The design and operation of condensers – worm tub (serpentines) and shell and tube.<br>Energy efficiency and effect on spirit quality of different condensers<br>Split cooling loads – latent heat and sensible heat (spirit cooler). |
| 30.4 | Collection of distillate | The design of the spirit safe and procedures for the collection of low wines, spirit and heads and tails. |
| 30.5 | Continuous (column) distillation | Layout and operation of a single column still. Feed position and feed condition. Top and bottom products. Reboiler or steam injection. Overhead condenser |
| 30.6 | Operation of the two column distillation process | The design and operation of ONE type of column still:<br>Armagnac still<br>Simple two column still<br>Two column modified Barbet still<br>Composition and preheating of the feed.<br>The distribution of flavour congeners in the rectifier.<br>Methods for the removal of fusel oils from the appropriate level of the rectifier and recovery as a co-product. Recovery and recycling of heads and tails.<br>Material balances over the still/s<br>Condensing and cooling systems.<br>Steam quality requirements |
| 30.7 | Control of product rectification for flavour | The distribution of flavour congeners in the rectifier.<br>Limiting product strength to produce a self-flavoured product. Collection at higher strength to reduce congener content.<br>Re-rectification to reduce/remove impurities.<br>Recovery and recycling of hot and cold feints.<br>Material balances over the still/s. |
| 30.8 | Removal of fusel oils | Composition of "fusel oil"<br>Reasons for removal from the still system.<br>Methods for the removal of fusel oils from the appropriate level of the rectifier.<br>Recovery as a co-product and basic principles of operation of fusel oil decanter and fusel oil still |
| 30.9 | Additional stills for neutral spirit production | The design and operation of continuous stills for NS production.<br>Function and sequence of the stills.<br>Extractive (hydroselective) distillation and re-rectification to reduce congeners.<br>Methods for removal of propanols, acetaldehyde and methanol. Heads purifying (acetaldehyde) column.<br>Methanol reduction column.<br>Recovery and recycling of hot and cold feints<br>Material balances over the still/s.<br>Condensing and cooling systems<br>Steam quality requirements |

# Syllabus Section 31: Post distillation control of flavour

**ONE OF THE FOLLOWING SECTIONS: 31A OR 31B**

**EITHER:**

## Section 31A: Maturation and Blending

| Syll. Ref. | Topics | Candidates should understand and be able to explain and describe in simple terms, or demonstrate familiarity with: |
|---|---|---|
| 31A.1 | Role of wood and wood treatment | Main types of cask wood: American and Spanish oak<br>Reasons for use of these woods: strength, no leakage, contribution to flavour.<br>Surface/volume ratio of different types of cask<br>Storage conditions, especially temperature and humidity<br>Effect of atmospheric oxygen. |
| 31A.2 | Changes occurring in the spirit over the process of maturation | Characteristics of new and mature spirit<br>Immature characters to be removed<br>Desirable mature characteristics<br>Evaporation (loss of high-volatile congeners)<br>Absorption into char layer of wood surface<br>Extraction of colour and flavour congeners, e.g. tannins, from wood<br>Reactions within the maturing spirit, e.g. oxidation, formation of esters |
| 31A.3 | Blending | 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.<br>Organisation of stock.<br>Choice of spirits, emptying casks, filtration, mixing, the importance of tasting and/or chemical analysis at critical points in the process |

**OR:**

**Syllabus section 31B: Gin and vodka production**

| Syll. Ref. | Topics | Candidates should understand and be able to explain and describe in simple terms, or demonstrate familiarity with: |
|---|---|---|
| 31B.1 | Quality of neutral spirit feedstock for gin and vodka | Quality standards for gin and vodka production |
| 31B.2 | Botanicals and methods of use for gin production | The principal plant materials that are used for the flavouring of gin.<br>How essential oils are preserved, and how and why botanicals are used in gin distillation.<br>Harvesting, drying, storage and use of botanicals in gin making.<br>Principles of distillation: cut points for heads, gin and tails<br>Production of flavouring extracts by solvent extraction or distillation<br>Quality requirements and principles of sensory evaluation of gin. |
| 31B.3 | Production of vodka from neutral spirit (charcoal filtration) | Requirement for removal of flavour congeners by redistillation.<br>Principles of hydro-selective distillation<br>Quality requirements and principles of sensory evaluation of vodka<br>Carbon treatment process. |

## Syllabus Section 32: Distillery Co-products

| Syll. Ref. | Topics | Candidates should understand and be able to explain and describe in simple terms, or demonstrate familiarity with: |
|---|---|---|
| 32.1 | Range of distillery co-products | Marc from grape pressing and fermentation lees.<br>Carbon dioxide from distillery fermentation.<br>"Fusel oil" from continuous distillation<br>Awareness of other waste streams of no commercial value: spent lees. |
| 32.2 | Marc/ Pomace | Uses of marc: grape spirit, compost, grape seed oil. |
| 32.3 | Carbon dioxide | Uses of liquid and solid $CO_2$<br>Requirement for purification by scrubber and catalyst columns before chilling and compressing $CO_2$ |

# END OF ELECTIVE C - GRAPE