




Institute of Brewing & Distilling

## **The General Certificate in Brewing (GCB)**

### **Examination Syllabus (May 2011)**

This document details the course of study necessary to prepare for the examination for the GCB (Chilled and Filtered, and Cask options). The specifications to which the respective examination papers are prepared are also shown.

	<b>Introduction.</b>
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The **General Certificate in Brewing** gives international recognition of a basic, underpinning knowledge and understanding in the principles of brewing operations.

The General Certificate in Brewing has been designed for candidates who may have little or no formal academic or technical qualification. Typically a candidate will be employed as a senior operator or team leader in a brewery or packaging plant, however the scope of these examinations will enable candidates from smaller brewing operations to obtain this recognised qualification. This examination is open to anybody with interest in brewing or beer packaging. They are a measure of basic knowledge (theoretical and practical) underpinning brewing, packaging and associated operations.

- The General Certificate in Brewing can be an end in itself, or the start of professional development, leading to the Diploma in Brewing (Dipl.Brew) and potentially, the Master Brewer (M.Brew) examinations. It counts as RPL (Recognised Prior Learning) for the Diploma in Beverage Packaging Module 2 Unit 2.5 Brewing.
- The General Certificate in Brewing has City & Guilds accreditation at Level 3 of the National Qualifications Framework in the UK (or equivalent internationally recognised standards),.
- The General Certificate in Brewing takes the form of one multiple choice paper of two hours.


Candidates can register to sit the exam on-line instead of using the traditional paper format. Candidates sitting within brewery or university centres will be encouraged to take the on-line version. The exam itself appears on the screen very much like the paper version and with the same number of questions, but there are various different ways of asking the questions which make the exam a more interesting experience. The marking is done electronically and candidates will receive a detailed feedback on how each section of the syllabus has been answered.

The pass mark is set at 66% (40 correct answers from 60 questions) for GC exams. Candidates attaining 90% or more achieve a Distinction pass and 80 - 89% achieves a Credit pass.

*GCB Syllabus (C&F and Cask)*

The full list of sections in the GCB syllabus is as follows:-

1. Beer types; their raw materials; sweet wort production.
2. Sweet wort production (methods and plant).
3. Wort boiling.
4. Wort clarification, cooling and oxygenation (aeration).
5. The basic principles of yeast fermentation.
6. Fermentation practice.
7. Yeast management.
8. Specialist section –
  - Either** 8CF Beer maturation and cold storage (for chilled and filtered beer option).
  - or** 8CSK Beer maturation and cooling (for cask beer option).
9. Specialist section –
  - Either** 9CF Bright beer preparation (for chilled and filtered beer option).
  - or** 9CSK Cask beer preparation and racking.
10. Beer quality and process control.
11. Beer quality – Flavour.
12. Beer quality – Dissolved oxygen.
13. Beer quality – Microbiological contamination.
14. Quality management.
15. Plant cleaning – Detergents and sterilizing agents.
16. Plant cleaning – Cleaning in-place (CIP) and general cleaning.
17. Engineering maintenance.
18. Utilities – Water and effluent in brewing
19. Utilities – Process gases.
20. Brewing and the environment.

	<b>Syllabus Section 1: Beer types; their raw materials; sweet wort production.</b>
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Ref.	Topics  (No. of questions to be answered = <b>5</b> )	<b>Candidates should understand and be able to explain and describe in simple terms, or demonstrate familiarity with:</b>
1.1	Definition of beer and types of beer	<ol style="list-style-type: none"> <li>1. A generic, non-legalistic definition of beer in terms of its typical ingredients and methods of production.</li> <li>2. Characteristics which differentiate lagers, ales and stouts.</li> </ol>
1.2	Barley and malt	<ol style="list-style-type: none"> <li>1. The role of barley as a principal source of starch.</li> <li>2. The special attributes of barley for malting.</li> <li>3. The significant changes that occur when the barley grain is malted.</li> <li>4. The principal constituents of malt.</li> <li>5. The key malt parameters of degree of modification, extract content, moisture content, extract, and colour.</li> <li>6. The selection of malt for beer type and mash conversion method.</li> <li>7. Pre-acceptance checks at malt intake.</li> </ol>
1.3	Adjuncts and coloured malts	<ol style="list-style-type: none"> <li>1. Reasons for the use of adjuncts.</li> <li>2. Types of adjunct and their method of use.</li> <li>3. Typical usage rate as proportion of the grist.</li> <li>4. Types of coloured malt and their characteristics.</li> <li>5. Typical uses of coloured malts.</li> </ol>

## GCB Syllabus (C&amp;F and Cask)

1.4	Mash conversion	<ol style="list-style-type: none"> <li>1. The respective roles of the amylases and protease, the effect of temperature, pH and time on their activity.</li> <li>2. Temperature and wort viscosity.</li> <li>3. The influence of the ionic composition (hardness salts) of mashing water in the mash and on beer flavour.</li> <li>4. The starch test.</li> <li>5. Key sweet wort parameters of fermentability. [See also section 10.2]</li> </ol>
1.5	Grist composition and extract performance	<ol style="list-style-type: none"> <li>1. The extract yield of raw materials.</li> <li>2. Malt and adjunct quantities required for a grist from theoretical material extract values.</li> <li>3. Calculation of brewhouse extract performance.</li> </ol>

	<b>Syllabus section 2: Sweet wort production (methods and plant).</b>
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Ref.	Topics  (No. of questions to be answered =4)	<b>Candidates should understand and be able to explain and describe in simple terms, or demonstrate familiarity with:</b>
2.1	Brewing process overview	<ol style="list-style-type: none"> <li>1. The sequence of events from raw material intake to the preparation of beer for packaging and the typical points of use for raw materials and process aids.</li> <li>2. A representation of the brewing process as a flow diagram.</li> </ol>
2.2	Brewhouse plant operation – grain handling and milling	<ol style="list-style-type: none"> <li>1. The purposes of milling with respect to the type of mashing / mash separation systems available.</li> <li>2. The significance of grist fraction analysis (expressed in quantitative terms) and its assessment.</li> <li>3. The operating principles and diagrammatic representation of malt mills and their associated malt preparation equipment.<sup>1</sup></li> <li>4. Grain handling and safety.</li> </ol>
2.3	Brewhouse plant operation – mashing and conversion	<ol style="list-style-type: none"> <li>1. The operating principles and diagrammatic representation of mashing/mash conversion systems, including the cereal-cooking vessel, if appropriate.<sup>2</sup></li> <li>2. An awareness of the operational differences between isothermal (mash-tun) conversion and temperature programmed conversion vessels.</li> <li>3. A quantitative knowledge of typical times, temperatures and grist ratios used in the conversion vessel.</li> <li>4. The qualitative assessment of starch conversion.</li> </ol>

2.4	Brewhouse plant operation – wort separation	<ol style="list-style-type: none"><li>1. The operating principles and diagrammatic representation of wort separation devices.</li><li>2. The significance of cycle times for brewhouse capacity.</li><li>3. Methods for the assessment of wort clarity / solids content.</li><li>4. Use of spent grains as a co-product.</li></ol>
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	<b>Syllabus section 3: Wort boiling.</b>
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Ref.	Topics  (No. of questions to be answered = 4)	<b>Candidates should understand and be able to explain and describe in simple terms, or demonstrate familiarity with:</b>
3.1	Wort boiling	<ol style="list-style-type: none"> <li>1. The purposes of boiling: sterilization, stabilization of enzyme action, evaporation, coagulation and precipitation of protein (trub formation) and beer haze precursors, flavour development other than hop bitterness [see 3.2 below], and colour formation.</li> <li>2. Factors affecting the effectiveness of wort boiling.</li> <li>3. The purposes of liquid adjunct additions to the wort kettle.</li> </ol>
3.2	Wort boiling systems	<ol style="list-style-type: none"> <li>1. The operating principles and diagrammatic representation of wort boiling systems.<sup>3</sup></li> <li>2. Typical boiling times and hop addition practices.</li> </ol>
3.3	The nature of hop bitterness	<ol style="list-style-type: none"> <li>1. The nature and origins of hops and hop products.</li> <li>2. Isomerization and how hops or hop products yield bitterness during wort boiling.</li> <li>3. How alternative or supplementary additions of hop bitterness are made at later stages in brewing.</li> </ol>
3.4	Hop calculations	<ol style="list-style-type: none"> <li>1. How bitterness value of beer is expressed and typical values.</li> <li>2. The bitterness potential of hops.</li> <li>3. Calculation of required hop addition rates to achieve a given beer bitterness.</li> <li>4. Calculation of hop utilization.</li> </ol>

	<b>Syllabus section 4: Wort clarification, cooling and oxygenation (aeration).</b>
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Ref.	Topics  (No. of questions to be answered = <b>3</b> )	<b>Candidates should understand and be able to explain and describe in simple terms, or demonstrate familiarity with:</b>
4.1	Wort clarification	<ol style="list-style-type: none"> <li>1. The potential of trub constituents, spent hops, etc in boiled wort to detract from beer quality.</li> <li>2. Methods available for kettle fining.</li> <li>3. Methods available for the removal of trub and / or spent hops.</li> <li>4. The basic operating principles and diagrammatic representation of wort clarification devices.<sup>4</sup></li> </ol>
4.2	Wort cooling	<ol style="list-style-type: none"> <li>1. The purposes of wort cooling.</li> <li>2. The effect of cooling on wort constituents.</li> <li>3. Methods available for cooling wort.</li> <li>4. The basic operating principles and diagrammatic representation of a type of wort cooler.</li> </ol>
4.3	Wort oxygenation / aeration	<ol style="list-style-type: none"> <li>1. The purpose of wort oxygenation. [See also section 5.2]</li> <li>2. Methods of wort oxygenation / aeration and values achievable.</li> <li>3. The basic operating principles and diagrammatic representation of wort oxygenation systems, including the air or oxygen sterilization equipment.</li> </ol>

	<b>Syllabus section 5: The basic principles of yeast fermentation.</b>
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Ref.	Topics  (No. of questions to be answered = <b>3</b> )	<b>Candidates should understand and be able to explain and describe in simple terms, or demonstrate familiarity with:</b>
5.1	Brewing yeast	<ol style="list-style-type: none"> <li>1. Basic understanding of the relationship of brewing yeast to other living organisms.</li> <li>2. The differences between the bottom-fermenting (lager) and top-fermenting (ale) yeasts in terms of their practical brewing applications.</li> <li>3. The microscopic appearance of a yeast cell.</li> <li>4. The nutritional requirements of yeast derived from wort including trace elements.</li> </ol>
5.2	Fermentation theory	<ol style="list-style-type: none"> <li>1. The production of alcohol and carbon dioxide from wort sugars by yeast.<sup>5</sup></li> <li>2. The main phases and events of brewery fermentations.</li> <li>3. The significance of the presence and absence of dissolved oxygen.</li> <li>4. Other factors affecting the phases of fermentations.</li> <li>5. Other factors affecting the speed of fermentations.</li> </ol>

	<b>Syllabus section 6: Fermentation practice.</b>
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<b>Ref.</b>	<b>Topics</b>  (No. of questions to be answered = <b>2</b> )	<b>Candidates should understand and be able to explain and describe in simple terms, or demonstrate familiarity with:</b>
6.1	Fermentation vessels and their control	<ol style="list-style-type: none"> <li>1. General knowledge of the basic requirements of brewery fermentation vessels.</li> <li>2. The operating principles and diagrammatic representation of fermentation vessels, the reasons for their choice, their advantages and disadvantages.<sup>6</sup></li> <li>3. Reasons for temperature control.</li> <li>4. Procedures for the temperature control of fermentations.</li> </ol>
6.2	Health and Safety	<ol style="list-style-type: none"> <li>1. The evolution of carbon dioxide from fermentations.</li> <li>2. The hazards associated with carbon dioxide.</li> <li>3. The monitoring / checking of atmospheres for safe working including a quantitative knowledge of exposure limits.</li> <li>4. Safe working practices for fermenting room operations.</li> </ol>

	<b>Syllabus section 7: Yeast management.</b>
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Ref.	Topics  (No. of questions to be answered = <b>2</b> )	<b>Candidates should understand and be able to explain and describe in simple terms, or demonstrate familiarity with:</b>
7.1	Yeast propagation, storage and cropping	<ol style="list-style-type: none"> <li>1. The reasons for yeast propagation.</li> <li>2. Basic procedures for producing a pure culture yeast.</li> <li>3. The operating principles and diagrammatic representation of a yeast culture plant.</li> <li>4. The purposes and timing of yeast cropping.</li> <li>5. The operating principles and diagrammatic representation of systems for the removal of yeast from a completed fermentation.<sup>7</sup></li> <li>6. The monitoring of yeast growth.</li> <li>7. The conditions necessary for the storage of either pressed or liquid yeast.</li> </ol>
7.2	Yeast selection, treatment and pitching	<ol style="list-style-type: none"> <li>1. The selection of yeast for pitching.</li> <li>2. Characteristics of healthy pitching yeast and the assessment of yeast condition and purity.</li> <li>3. Acid washing procedures including a quantitative knowledge of time, temperature and pH ranges.</li> <li>4. Yeast pitching methods.</li> <li>5. The calculation of yeast pitching rate for a fermentation.</li> </ol>

	<b>Syllabus section 8CF: Beer maturation and cold storage (for chilled and filtered beer option).</b>
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Ref.	Topics  (No. of questions to be answered = <b>2</b> )	<b>Candidates should understand and be able to explain and describe in simple terms, or demonstrate familiarity with:</b>
8.1	Warm maturation	<ol style="list-style-type: none"> <li>1. The purposes of warm maturation.</li> <li>2. Typical times and temperatures appropriate to different beer types.</li> <li>3. Typical changes during affecting beer flavour. [See also section 11.1]</li> </ol>
8.2	Cold storage and stabilization	<ol style="list-style-type: none"> <li>1. The purposes of cold storage.</li> <li>2. Typical times and temperatures appropriate to different beer types.</li> <li>3. The general principles of stabilization.</li> <li>4. Haze precursors and their removal.</li> <li>5. The nature and action of the principal types of stabilizing agents.</li> </ol>

	<b>Syllabus section 8CSK: Beer maturation and cooling (for cask beer option).</b>
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Ref.	Topics  (No. of questions to be answered = <b>1</b> )	<b>Candidates should understand and be able to explain and describe in simple terms, or demonstrate familiarity with:</b>
8.1	Maturation and Cooling	<ol style="list-style-type: none"> <li>1. The purposes of warm maturation.</li> <li>2. Typical times and temperatures appropriate to different beer types.</li> <li>3. Typical changes during maturation that affect beer flavour.</li> <li>4. The purposes of cooling in vessel.</li> <li>5. The operating principles and diagrammatic representation of beer chillers.</li> </ol>

	<b>Syllabus section 9 CF: Bright beer preparation (for chilled and filtered beer option).</b>
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Ref.	Topics  (No. of questions to be answered = 4)	<b>Candidates should understand and be able to explain and describe in simple terms, or demonstrate familiarity with:</b>
9.1	Chilling and carbonation	<ol style="list-style-type: none"> <li>1. The operating principles and diagrammatic representation of a beer chiller (plate or shell and tube).</li> <li>2. The purposes of carbonation.</li> <li>3. Typical dissolved CO<sub>2</sub> levels for different beer types.</li> <li>4. Location in process of carbonation points.</li> <li>5. The operating principles and diagrammatic representation of a carbonator.</li> </ol>
9.2	Filtration	<ol style="list-style-type: none"> <li>1. The purposes of filtration.</li> <li>2. The principles of filtration – sieving, depth and absorption.</li> <li>3. The origin, nature and preparation of filter aid – diatomaceous earth (kieselguhr) and perlite.</li> <li>4. The operating principles of a rough beer filter.</li> <li>5. The types of beer sterilizing (polishing) filters available.</li> <li>6. Representation of the sequence of events in a typical filtration system as a flow diagram.</li> <li>7. Awareness of alternative rough beer filter types – cross flow filtration.</li> <li>8. The health and safety hazards associated with filter aids. Personal protection equipment (PPE) and the plant safety features necessary.</li> </ol>

9.3	High gravity dilution	<ol style="list-style-type: none"><li>1. Reasons for brewing at high gravity.</li><li>2. Typical quality specifications for water to be used for dilution (quantitative data required).</li><li>3. The calculation of blending quantities.</li></ol>
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	<b>Syllabus section 9CSK: Cask beer preparation and racking.</b>
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Ref.	Topics  (No. of questions to be answered = 5)	<b>Candidates should understand and be able to explain and describe in simple terms, or demonstrate familiarity with:</b>
9.1	Preparation of cask ale following fermentation	<ol style="list-style-type: none"> <li>1. The purposes of cask conditioning.</li> <li>2. The importance of controlling yeast concentration / count, and typical values.</li> <li>3. Conditioning and the necessity for residual fermentable sugars, with typical values.</li> </ol>
9.2	Clarification	<ol style="list-style-type: none"> <li>1. The origin, nature and action of auxiliary finings.</li> <li>2. The origin, nature and action of isinglass finings.</li> <li>3. Storage of prepared finings prior to use.</li> <li>4. Typical addition rates and procedures for finings.</li> <li>5. The operating principles and diagrammatic representation of finings addition equipment.</li> </ol>
9.3	Priming and addition of hop products to cask	<ol style="list-style-type: none"> <li>1. Reasons for the addition of priming sugar.</li> <li>2. Types of hops and hop products used for cask beer.</li> <li>3. Reasons for addition of hops or hop products.</li> </ol>
9.4	Cask washing and racking	<ol style="list-style-type: none"> <li>1. Preparation and inspection of casks for filling.</li> <li>2. Typical cask racking installations.<sup>8</sup></li> <li>3. Cask filling practice, typical temperature specification for beer at racking, filling volume control.</li> </ol>
9.5	Conditioning in cask	<ol style="list-style-type: none"> <li>1. Storage temperature during conditioning, in the supply chain and at the point of sale.</li> <li>2. The use of soft and hard pegs.</li> <li>3. Factors influencing shelf life.</li> </ol>

	<b>Syllabus section 10: Beer quality and process control.</b>
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Ref.	Topics  (No. of questions to be answered = <b>2</b> )	<b>Candidates should understand and be able to explain and describe in simple terms, or demonstrate familiarity with:</b>
		<p><i>Key parameters examined in this section are:</i></p> <p><i>Original gravity (OG), present gravity (PG), alcohol content (ABV %), pH, colour, haze, bitterness, head retention or foam stability, dissolved oxygen, dissolved carbon dioxide.</i></p>
10.1	Process specifications	<ol style="list-style-type: none"> <li>1. The variable nature of the natural ingredients of beer.</li> <li>2. The purpose of process specifications.</li> <li>3. Effects of the brewing process on the final product value of these key parameters.</li> </ol>
10.2	Process control	<ol style="list-style-type: none"> <li>1. The principles of monitoring and adjustment to achieve product consistency.</li> <li>2. Simple statistical quality control procedures.</li> <li>3. The concepts of tolerance and range for specification parameter values.</li> <li>4. Typical specifications which differentiate beer types.</li> <li>5. Typical process specification ranges, especially those requiring periodic adjustment to achieve product consistency [see Ref 10.1.above].</li> <li>6. Typical applications for in-line and on-line instruments for process control.</li> </ol>

	<b>Syllabus section 11: Beer quality – Flavour.</b>
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Ref.	Topics  (No. of questions to be answered = <b>2</b> )	<b>Candidates should understand and be able to explain and describe in simple terms, or demonstrate familiarity with:</b>
11.1	Terminology	<ol style="list-style-type: none"> <li>1. The reasons for adopting industry standard descriptors for flavour.</li> <li>2. The flavour wheel.</li> <li>3. The more commonly used components.</li> <li>4. Taste training procedures.</li> </ol>
11.2	Evaluation and tasting during brewing operations	<ol style="list-style-type: none"> <li>1. The three-glass test – statistical significance rating.</li> <li>2. Flavour profiling.</li> <li>3. Trueness to type panel tasting.</li> <li>4. Common faults / contamination by contact materials that may be detected by tasting during brewing operations.</li> </ol>

	<b>Syllabus section 12: Beer quality – Dissolved oxygen.</b>
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Ref.	Topics  (No. of questions to be answered = <b>2</b> )	<b>Candidates should understand and be able to explain and describe in simple terms, or demonstrate familiarity with:</b>
12.1	The spoilage of beer by oxygen	<ol style="list-style-type: none"> <li>1. Sensitivity of beer to small amounts of oxygen – typical levels causing spoilage.</li> <li>2. Basic mechanism for haze formation.</li> <li>3. Oxidation reactions to form flavour compounds.</li> <li>4. Typical flavour descriptors for oxidation effects.</li> <li>5. Oxygen as a constituent of air.</li> <li>6. Typical points of exposure of beer to air.</li> </ol>
12.2	Monitoring and control of dissolved oxygen levels	<ol style="list-style-type: none"> <li>1. Key control points.</li> <li>2. The significance of sampling time.</li> <li>3. Operating a dissolved oxygen meter.</li> <li>4. Typical specified maximum levels.</li> <li>5. Good practices to avoid oxygen pick-up.</li> <li>6. The use of sulphur dioxide, ascorbic acid and potassium meta-bisulphite (KMS).</li> </ol>

	<b>Syllabus section 13: Beer quality – Microbiological contamination.</b>
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Ref.	Topics  (No. of questions to be answered = 4)	Candidates should understand and be able to explain and describe in simple terms, or demonstrate familiarity with:
13.1	Beer spoilage	<ol style="list-style-type: none"> <li>1. Anaerobic growth.</li> <li>2. Typical spoilage products formed.</li> <li>3. Effects on beer quality of microbiological spoilage, appropriate use of flavour descriptors to describe spoilage. [See also section 12.1]</li> </ol>
13.2	Spoilage organisms	<ol style="list-style-type: none"> <li>1. The principal categories of spoilage organisms: <i>Pediococcus</i>, <i>Lactobacillus</i>, <i>Acetobacter</i>, <i>Obesumbacterium</i>, <i>Megasphaera</i>, wild yeasts:               <ul style="list-style-type: none"> <li>- their common points of contamination in the brewery</li> </ul> </li> </ol>
13.3	Detection and monitoring	<ol style="list-style-type: none"> <li>1. Methods of sampling for microbiological testing.</li> <li>2. Sampling points.</li> </ol>
13.4	Control	<ol style="list-style-type: none"> <li>1. Practices to protect against infection.</li> <li>2. Measures to combat known sources of infection.</li> </ol>

	<b>Syllabus section 14: Quality management.</b>
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Ref.	Topics  (No. of questions to be answered = <b>3</b> )	<b>Candidates should understand and be able to explain and describe in simple terms, or demonstrate familiarity with:</b>
14.1	Features of a quality system	1. The key features of a quality system: <ul style="list-style-type: none"> <li>- written specifications</li> <li>- written procedures</li> <li>- monitoring of performance</li> <li>- corrective actions</li> <li>- auditing</li> <li>- regular reviews for improvement</li> </ul>
14.2	Roles responsibilities and benefits	1. The impact of individual actions on product and service quality. 2. The control of documentation. 3. The maintenance of conformity. 4. The business benefits of an effective quality management system.
14.3	Product safety	1. The control of product safety <ul style="list-style-type: none"> <li>- Hazard Analysis Critical Control Point (HCCP).</li> </ul> 2. The importance of traceability for product recall.

	<b>Syllabus topic 15: Plant Cleaning - Detergents and sterilizing agents.</b>
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Ref.	Topics  (No. of questions to be answered = 4)	<b>Candidates should understand and be able to explain and describe in simple terms, or demonstrate familiarity with:</b>
15.1	Detergents	<ol style="list-style-type: none"> <li>1. Types of detergent (alkali, acid and neutral).</li> <li>2. The constituents of detergents.</li> <li>3. The individual functions of the constituents.</li> <li>4. Criteria for choice of detergent for an application.</li> <li>5. Considerations for the use of hot detergent cleaning.</li> </ol>
15.2	Sterilants	<ol style="list-style-type: none"> <li>1. Types of sterilant as defined by the active agent.</li> <li>2. Criteria for choice of sterilant for an application.</li> <li>3. The effect of sterilant residues on beer quality.</li> </ol>
15.3	Heat sterilization	<ol style="list-style-type: none"> <li>1. Uses of steam and hot water as a sterilant.</li> <li>2. Time and temperature.</li> </ol>
15.4	Safety	<ol style="list-style-type: none"> <li>1. The hazards associated with chemical cleaning and sterilizing agents.</li> <li>2. Good practices for the storage of chemicals.</li> <li>3. Use of personal protective equipment (PPE).</li> <li>4. Procedures in case of accidental spillage or discharge of chemicals.</li> </ol>

	<b>Syllabus section 16: Plant cleaning - Cleaning in-place (CIP) and general cleaning.</b>
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Ref.	Topics  (No. of questions to be answered = 4)	<b>Candidates should understand and be able to explain and describe in simple terms, or demonstrate familiarity with:</b>
16.1	Types of CIP systems	<ol style="list-style-type: none"> <li>1. The general differences between single use and recovery systems – advantages and disadvantages.</li> <li>2. The types of cleaning head used and reasons for their choice.</li> <li>3. The operating principles and diagrammatic representation of CIP systems.</li> </ol>
16.2	CIP cleaning cycles	<ol style="list-style-type: none"> <li>1. Typical cleaning programs and cycle times.</li> <li>2. The function of each of the cleaning cycle stages.</li> <li>3. Quality assurance of cleaning operations.</li> </ol>
16.3	CIP plant design hygiene considerations	<ol style="list-style-type: none"> <li>1. Design features that minimize soil accumulation in brewery vessels and pipelines.</li> <li>2. Design features that facilitate vessel and pipeline cleaning using a CIP system.</li> <li>3. Design features which promote a hygienic working environment.</li> </ol>
16.4	General plant cleaning	<ol style="list-style-type: none"> <li>1. Cleaning plant surfaces, walls and floors.</li> <li>2. The constituents of foam cleaning agents.</li> <li>3. The use of foaming systems.</li> </ol>

	<b>Syllabus section 17: Engineering maintenance.</b>
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Ref.	Topics  (No. of questions to be answered = <b>3</b> )	<b>Candidates should understand and be able to explain and describe in simple terms, or demonstrate familiarity with:</b>
17.1	Objectives and approaches	<ol style="list-style-type: none"> <li>1. The key business reasons for an effective maintenance system.</li> <li>2. The features, advantages, disadvantages and applications of: <ul style="list-style-type: none"> <li>- no maintenance</li> <li>- breakdown maintenance</li> <li>- preventive maintenance</li> <li>- predictive maintenance</li> </ul> </li> <li>3. The contribution of maintenance tasks to plant safety, reliability, quality, economics and environmental impact.</li> </ol>
17.2	Maintenance tasks	<ol style="list-style-type: none"> <li>1. Familiarity with key maintenance tasks: <ul style="list-style-type: none"> <li>- mechanical</li> <li>- electrical</li> <li>- calibration</li> <li>- inspection</li> <li>- condition monitoring</li> <li>- cleaning of plant</li> <li>- health and safety</li> </ul> </li> <li>2. Maintenance planning and record keeping.</li> <li>3. Autonomous maintenance.</li> </ol>
17.3	Systems for continuous improvement	<ol style="list-style-type: none"> <li>1. The key features of the following performance improvement systems: <ul style="list-style-type: none"> <li>- Reliability Centred Maintenance (RCM)</li> <li>- Total Productive Maintenance (TPM)</li> <li>- Workplace Organisation (5S)</li> </ul> </li> </ol>

	<b>Syllabus section 18: Utilities – Water and effluent in brewing.</b>
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Ref.	Topics  (No. of questions to be answered = <b>3</b> )	<b>Candidates should understand and be able to explain and describe in simple terms, or demonstrate familiarity with:</b>
18.1	Water sources and treatments	<ol style="list-style-type: none"> <li>1. Characteristics and quality of an ideal brewery water supply.</li> <li>2. Sources of water for a brewery.</li> <li>3. The basic principles and diagrammatic representation treatment plants for: <ul style="list-style-type: none"> <li>- water filtration</li> <li>- water sterilization</li> <li>- water softening / deionization</li> <li>- water de-aeration</li> </ul> </li> </ol>
18.2	Water types and uses	<ol style="list-style-type: none"> <li>1. Differentiation and typical uses of: <ul style="list-style-type: none"> <li>- de-aerated water</li> <li>- process water</li> <li>- service water</li> </ul> </li> <li>2. <i>Legionella</i> in cooling water and service water and the health risks associated with the micro-organism.</li> <li>3. Points at which water is introduced into the process and the special water quality needed at these points.</li> </ol>
18.3	Sources of effluent and its measurement	<ol style="list-style-type: none"> <li>1. The nature and characteristics of effluent from principal brewery operations.</li> <li>2. The components of effluent quality: <ul style="list-style-type: none"> <li>- volume</li> <li>- suspended solids (SS)</li> <li>- chemical oxygen demand (COD)</li> <li>- biological oxygen demand (BOD)</li> <li>- pH</li> <li>- temperature</li> </ul> </li> </ol>

	<b>Syllabus Section 19: Utilities – Process gases.</b>
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Ref.	Topics  (No. of questions to be answered = <b>1</b> )	<b>Candidates should understand and be able to explain and describe in simple terms, or demonstrate familiarity with:</b>
19.1	Properties, applications and safety	<ol style="list-style-type: none"> <li>1. The essential properties and quality of compressed air and oxygen for use as process gases.</li> <li>2. The essential properties of carbon dioxide and nitrogen for use as process gases.</li> <li>3. The practice and benefits of carbon dioxide collection.<sup>9</sup></li> <li>4. The significance of inertness.</li> <li>5. Typical uses for process gases.</li> <li>6. The economic importance of leak prevention.</li> <li>7. Safe handling and storage of compressed gas cylinders.</li> <li>8. Safety hazards associated with storage of liquid gases and their distribution in high-pressure mains.</li> </ol>

	<b>Syllabus section 20: Brewing and the environment.</b>
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<b>Ref.</b>	<b>Topics</b>  (No. of questions to be answered = <b>3</b> )	<b>Candidates should understand and be able to explain and describe in simple terms, or demonstrate familiarity with:</b>
20.1	Sustainability and climate change	<ol style="list-style-type: none"> <li>1. The concept of a sustainable industry.</li> <li>2. The role of carbon dioxide – the carbon cycle.</li> <li>3. Sources of carbon dioxide emissions.</li> </ol>
20.2	Conservation	<ol style="list-style-type: none"> <li>1. Principal energy consuming activities in a brewery.</li> <li>2. Typical energy reduction strategies.</li> <li>3. Principal water consuming activities.</li> <li>4. Typical water conservation strategies.</li> </ol>
20.3	Waste	<ol style="list-style-type: none"> <li>1. Principal waste generating activities in a brewery.</li> <li>2. Issues for waste disposal.</li> <li>3. Strategies to minimize waste and encourage recycling.</li> </ol>

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**Notes for examiners and tutors.**

- <sup>1</sup> Options include 4, 5, and 6 –roll dry mills, wet mill, and hammer mill. The malt preparation equipment, appropriate to the type of mill, includes screens, destoners, weighers and malt conditioning devices. Candidates should be aware of the different operating principles of a dry roll mill, a wet mill and a hammer mill, and their association with the type of mash separation device used.
- <sup>2</sup> . For decoction systems incorporating a cereal cooker, familiarity with the plant configuration is expected but the quantitative data required is restricted to the temperatures achieved in the main conversion vessel. Details of volumes and cereal temperatures are not required.
- <sup>3</sup> Candidates may be aware of other systems, but questions will only be asked on ‘traditional’ wort boiling systems.
- <sup>4</sup> Wort filtration systems using filter aids are not required.
- <sup>5</sup> Knowledge of metabolic pathways and yeast enzymes is not required.
- <sup>6</sup> No knowledge of continuous fermentation systems is required.
- <sup>7</sup> Includes green beer centrifuging, though questions will not be asked about the centrifuges themselves.
- <sup>8</sup> A detailed knowledge of cask washing and filling machinery is not required, but candidates should be familiar with the sequence of events and any conditions required during the washing and filling processes.
- <sup>9</sup> No knowledge of the collection and compression plant is required. Candidates should be aware of the economic and environmental arguments for collection [see section 20] and the operational procedures for the timing of collection.