Chartered Institute of Brewers and Distillers

Diploma in Brewing

Module 3 Syllabus

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UNIT 1: RESOURCE MANAGEMENT

Candidates are required to have an in-depth understanding of the following:

Environmental Sustainability

1. Understand the global context for sustainable development.

   i. Sustainability Context and Key Concepts
   ii. What does sustainable mean?
   iii. UN Sustainable Development Goals

2. Understand the key drivers of climate change, its impacts and mitigation opportunities.

   i. Climate Action
   ii. Impacts of Climate Change
   iii. What is the Global Community doing to Combat Climate Change?
   iv. Why does Climate Action Matter to Brewers?

3. Describe key environmental impacts of brewing that can be controlled or reduced; especially water and energy use and waste.

   i. Circular Economy

4. Describe the management techniques available to increase environmental sustainability of brewery operations such as water and energy use.

   i. Energy and Carbon Management
   ii. Energy and Carbon Management Continued
   iii. Key Steps to Implementing an Energy Management System
   iv. Energy and Carbon Improvement Projects
   v. Water Management

5. Identify opportunities for innovation that reduce environmental impact from brewing.

   i. Understanding our Watershed Context
   ii. How Much Water?
   iii. Water Management Systems
   iv. Water Use Improvement Projects
   v. Solid Waste
   vi. Waste Management Principles
   vii. Waste Reduction
   viii. Co-products
   ix. Feedstocks, Processes, and Products

Health and Safety

1. Understand the types of health and safety legislation which may apply to a brewery, and the actions required by the owners, managers and employees.

    i. Safety First
    ii. Occupational Health and Safety in the Brewing Industry
    iii. Relevant National and Local Legislation and Regulations

2. Understand how health and safety should be managed within an organisation.

    i. Notices, Signs and Signals
    ii. Health and Safety in the Organisation
    iii. Behaviour Based Safety (BBS)

3. Conduct risk assessments using various risk identification methods.

    i. Brewery Hazards and Risks
    ii. Risk Evaluation

4. Describe the key hazards found in a brewery, including knowledge of dust and ammonia risk control.

    i. Key Risks
    ii. Key Risks – Chemicals
    iii. Key Risks – Gas

5. Appreciate the importance of near miss and accident investigations.

    i. Near Miss and Accident Investigation

Maintenance

1. Understand the goals and deliverables of a maintenance programme.

    i. What Are the Goals of Brewery Maintenance?
    ii. Successful Maintenance Approaches

2. Describe the features, advantages, disadvantages, and applications of no maintenance, run to failure (RTF), preventative maintenance (PM), and predictive maintenance (PdM).

    i. Maintenance Approach: No Maintenance
    ii. Maintenance Approach: Run-To-Failure (RTF)
    iii. Maintenance Approach: Preventative Maintenance (PM)
    iv. Maintenance Approach: Predictive Maintenance (PdM)

3. Explain the main elements required to successfully set up and run a maintenance programme and department.

    i. Maintenance Approach Summary: Putting It All Together

4. Demonstrate a clear understanding of how maintenance is executed across brewing.

    i. Establishment and Evolution of a Brewery Maintenance Programme

5. Compare the relationships between maintenance and safety, reliability, quality, economics, and envi ronmental impact.

    i. Implementation: The True Nuts and Bolts of Maintenance

6. Understand the statutory (legal and legislative) maintenance requirements and obligations.

    i. Maintenance Regulations and Guidance

7. Recognise and explain the importance of partnering design and engineering to provide a robust, safe, and flexible brewery.

    i. Maintenance by Design
    ii. The True Cost of Assets

UNIT 2: FLUID MECHANICS

Candidates are required to have an in-depth understanding of the following:

Principles of Fluid Mechanics 1

1. Describe the concept of viscosity related to fluids.

    i. Definition of Fluids

2. Explain the difference between Newtonian and non-Newtonian fluids, as described by Newton's law of viscosity.

    i. Viscosity and Newton's Law of Viscosity
    ii. The Units of Dynamic Viscosity
    iii. Non-Newtonian Fluids

3. Solve static fluid problems to determine the value of pressure in practical situations and understand which parameters can influence the value of pressure.

    i. Fluid Statics & Dynamics
    ii. Fluid Statics
    iii. Gauge and Absolute Pressures
    iv. Vertical Differences of Height
    v. The Concept of Head
    vi. Horizontal Distances – A Special Consideration

4. Describe different types of pressure instrumentation.

    i. Pressure Measurement
    ii. Differential or U-tube Manometer
    iii. The Bourdon Gauge

Principles of Fluid Mechanics 2

1. Understand and be able to apply the concept of mass and energy conservation to pipe and duct flows.

    i. Fluid Dynamics
    ii. Conservation of Mass
    iii. Conservation of Energy
    iv. Accounting for Gravitational Potential, Kinetic and Pressure Energies
    v. Bernoulli's Equation – Brewery Application

2. Apply the concept of the Reynolds number to defining laminar, transitional or turbulent pipe flows in circular and non-circular geometries.

    i. Velocity Regimes: Laminar, Transitional, and Turbulent
    ii. Laminar Flow
    iii. Turbulent Flow
    iv. Transitional Flow

3. Describe common brewery fluids which are transported under laminar or turbulent flow conditions.

    i. Determining Re for Non-circular Pipes/Ducts

Principles of Fluid Mechanics 3

1. Describe the contribution and causes of frictional and fitting pressure losses to the pressure drop in a pipe or duct system.

    i. The Loss of Energy in Pipe Systems – in Practice
    ii. Frictional Pressure Losses

2. Apply the Darcy-Weisbach equation and Moody diagram to quantify frictional pressure drop.

    i. The Friction Factor φ
    ii. Pressure Drop, Friction, and the Darcy-Weisbach Equation

3. Apply the loss coefficient approach to quantify pressure losses due to pipe and duct fittings.

    i. Quantifying Fitting Pressure Losses
    ii. Loss Coefficient (k)
    iii. Fitting Pressure Loss – Worked Example
    iv. Combining Frictional and Fitting Pressure Losses
    v. Fitting Pressure Loss

4. Specify typical design pipe and duct velocities and pressure drops.

    i. Design Flow Rates and Frictional Pressure Drops

Control of Fluid Flow 1

1. Describe the principle of operation of centrifugal and positive displacement pumps.

    i. Centrifugal Pumps
    ii. Impeller Design Types
    iii. Centrifugal Pump Operating Characteristics

2. Recommend pump types for different brewery applications.

    i. Pump Mechanical Shaft Seals
    ii. Positive Displacement Pumps
    iii. Rotary Displacement Pumps
    iv. Pumps in Series

3. Discuss the various criteria used to define pump performance.

    i. Pump Performance

4. Describe the principle of matching a pump performance to a piping system requirement using the pump-curve approach and apply this principle to simple situations.

    i. Matching Pump Characteristics to Pumping Duty

5. Describe the approaches of flow rate control and pump starting procedures.

    i. Control of Pumps
    ii. Pump Flow Control

Control of Fluid Flow 2

1. Describe the process of cavitation, including its causes and consequences for product quality and equipment integrity.

    i. Cavitation
    ii. Dissolved Gas Evolution

2. Compare and contrast the related concepts of available net positive suction head and required net positive suction head.

    i. Net Positive Suction Head (NPSH) – NPSHA
    ii. Net Positive Suction Head (NPSH) – NPSHR

3. Apply the concept of net positive suction head to pump operation and system design to ensure that cavitation does not occur.

Control of Fluid Flow 3

1. Describe the difference between on-off and modulating flow control and give brewing examples.
2. Describe the concept of valve flow rate characteristic and explain why it is important for different aspects of flow control.

3. Discuss various valve types and their principle of operation.

   i. Valve Types – Butterfly Valve
   ii. Ball Valve
   iii. Gate Valve
   iv. Globe Valve
   v. Non-return Valve
   vi. Pressure Relief Valve
   vii. Vacuum Relief Valve
   viii. Pressure Reducing Valve
   ix. Sampling Valve

4. Explain the concept of block and bleed and double-seat mixproof valves as a means of managing valve leakage.

   i. Valve Leakage

UNIT 3: GASES

Candidates are required to have an in-depth understanding of the following:

Gas Laws

1. Apply the gas laws of Boyle, Charles, and Gay-Lussac to describe the behaviour of a volume of gas under pressure and temperature.

   ii. Gas Laws – Boyle's Law
   iii. Gas Laws – Charles' Law
   iv. Gas Laws – Gay-Lussac Law

2. Apply the ideal gas law in determining ideal gas behaviour, including estimating gas density changes with pressure and temperature.

   v. Universal Gas Law – The Mole
   vi. Universal Gas Law
   vii. Specific Gas Constant R
   viii. Ideal Gases

3. Describe and apply Dalton's law to gas mixtures.

   ix. Dalton's Law of Gas Mixtures
   x. Dalton's Law and Partial Pressures
   xi. Molar Fractions

Gas Transfer

1. Describe and apply Dalton's and Henry's laws to gas mixtures to calculate saturated concentrations of dissolved gases in liquids.

    i. Saturation and Henry's Law with Mixed Gases

2. Use CO2 saturation tables and correlations to determine saturated concentrations of CO2 in beer.

    i. Practical Gas Solubility
    ii. CO2 Volumes/Volume (at STP)

3. Describe the process of super-saturation and how to avoid it or promote it.

    i. Super-Saturation

4. Describe the key parameters which affect the rate of gas transfer and recommend methods for gas transfer rate enhancement.

    i. Gas Transfer
    ii. Gas Transfer Dynamics
    iii. Gas Transfer Technology

5. Describe common examples of gas transfer technologies.

UNIT 4: HEAT TRANSFER

Candidates are required to have an in-depth understanding of the following:

Principles of Heat Transfer and Conduction

1. Describe the different forms of heat energy.

    i. Sensible Heat
    ii. Latent Heat

2. Describe the different ways that heat energy can travel through matter.

    i. Exothermic and Endothermic Reactions
    ii. Mechanisms of Heat Transfer
    iii. Steady State and Unsteady State Heat Transfer

3. Determine whether a material is a conductor or an insulator.

    i. Conduction

4. Explain how heat is transferred through a wall or pipe with or without insulation.

Convection

1. Describe the mechanism by which convective heat transfer occurs at a solid surface, between it and the fluid adjacent to it.

    i. The Boundary Layer

2. Define and explain the importance of the film heat transfer coefficient.

    i. Film Heat Transfer Coefficient

3. Describe and give examples of natural and forced convection.

    i. Fourier's Law Applied to Convection
    ii. Natural Convection
    iii. Forced Convection

4. Describe the mechanisms of boiling and condensation.

    i. Boiling and Condensation Heat Transfer
    ii. Heat Transfer from Condensing Liquids

Radiation and Combined

1. Describe and provide examples of heat transfer by radiation.

    i. Radiation
    ii. Stefan–Boltzmann Law
    iii. Radiation Applications
    iv. Radiation Enhancement and Mitigation

2. Describe and provide examples of scenarios when multiple forms of heat transfer are combined.

    i. Combined Heat Transfer: Convection and Conduction
    ii. Fouling Factors
    iii. Thick versus Thin Wall Pipes
    iv. Combined Heat Transfer by Conduction, Convection, and Radiation

3. Define and calculate the overall heat transfer coefficient for a combined heat transfer process.

Heat Exchangers

1. Describe the various heat exchangers used in brewing beer, their key components, and applications.

    i. Principles of Heat Transfer in Heat Exchangers
    ii. Flow Configurations in Heat Exchangers
    iii. Heat Exchanger Passes
    iv. Plate Heat Exchangers

Heat Exchangers

1. Describe the various heat exchangers used in brewing beer, their key components, and applications.

    i. Principles of Heat Transfer in Heat Exchangers
    ii. Flow Configurations in Heat Exchangers
    iii. Heat Exchanger Passes
    iv. Plate Heat Exchangers
    v. Plate Heat Exchangers Components and their Assembly
    vi. Plate Heat Exchanger – Plate Design
    vii. Shell and Tube Heat Exchangers
    viii. Shell and Tube Heat Exchanger – Components and Assembly
    ix. Types of Shell and Tube Heat Exchangers
    x. Shell and Tube Heat Exchanger Tube Design and Configuration

2. Demonstrate how the configuration of a heat exchanger influences the exchanger design and performance.

    i. Plate Heat Exchanger Gaskets
    ii. Eliminating Risk of Product Contamination
    iii. Plate Heat Exchanger – Fluid Mechanics
    iv. Shell and Tube Exchanger – Fluid Mechanics

3. Explain, using the principles of heat transfer, how heat is transferred in a heat exchanger, and the factors affecting the rate of heat transfer.

    i. Heat Transfer Mechanism in Heat Exchangers
    ii. Overall Heat Transfer Coefficient in Heat Exchangers
    iii. Temperature Driving Force in Heat Exchangers

4. Be able to select and size the appropriate heat exchanger for an application in a brewery and explain the pros and cons of your selection.

    i. Selecting the Heat Exchanger Type and Configuration
    ii. Sizing a Heat Exchanger

5. Explain why the actual performance of a heat exchanger varies from design and how this can be managed in a brewery.

    i. Cleaning Heat Exchangers
    ii. Maintaining and Operating Heat Exchangers

Jacketed Vessels

1. Describe the application of jacketed vessels along with their key components and functions.

    i. Types of Vessel Heating and Cooling

2. Show how the configuration of a jacketed vessel influences its design and performance.

   i. Jacketed Vessels: Design Considerations
   ii. Conventional Jackets
   iii. Dimpled Jacket
   iv. Half-Pipe Jackets

3. Using the principles of heat transfer, explain how heat is transferred in a jacketed vessel and the various factors affecting this.

   i. Heat Transfer Within a Jacketed Vessel

4. Select and size a jacketed vessel for an application in a brewery; explain the pros and cons of your selection.

   i. Features of Jacketed Vessels
   ii. Design and Sizing of Jacketed Vessels

5. Explain why the actual performance of a jacketed vessel varies from its design specifications, and state how this can be managed in a brewery.

   i. Control of Jacketed Vessels
   ii. Considerations for Maintaining and Operating Jacketed Vessels

UNIT 5: UTILITIES PART 1 (STEAM AND REFRIDGERATION)

Candidates are required to have an in-depth understanding of the following:

Steam Theory

1. Describe the benefits of using steam as a heating medium in a brewery.

   i. Steam Properties

2. Understand how to use a Mollier chart and steam tables.

   i. Mollier Diagram and Steam Tables
   ii. Mollier Chart Example
   iii. Steam Tables

3. Give definitions of, and describe the production methods of, both utility and culinary steam.

   i. Types of Steam

Steam Technology

1. Describe the operation of boilers.

    i. Steam Generation: Boilers
    ii. Steam Generation: Boiler Combustion

2. Understand the importance of boiler safety.

    i. Boiler Safety

3. Explain the function of the components that form part of a steam reticulation system.

    i. Water Supply and Treatment
    ii. Steam Distribution
    iii. Steam Line Fittings and Equipment
    iv. Steam Metering
    v. Condensate Recovery
    vi. Uses of Steam

Refrigeration Theory and Cycle

1. Understand the difference between cooling and attemperation, and describe where you can find examples of these processes in a brewery.

    i. Overview of Refrigeration

2. Explain and demonstrate the use of the refrigeration cycle.

    i. Refrigeration Principles
    ii. Refrigeration Cycle

3. Explain what a coefficient of performance is and describe its significance in the brewery.

    i. Energy Quantification
    ii. Coefficient of Performance
    iii. Conditions for Efficient Refrigeration Plant Operation

Refrigeration Technology

1. Describe the operation of the equipment most commonly used in the primary refrigeration process.

    i. Primary Refrigerants

2. Compare the required properties of common primary and secondary refrigerants.

    i. Common Primary Refrigerants in Breweries
    ii. Secondary Refrigerants

3. Describe how refrigeration is used in the brewery.

    i. Refrigeration Process Overview – The Vapour Compression Cycle
    ii. Compressors
    iii. Screw Compressors
    iv. Reciprocating Compressors
    v. Condensers
    vi. High Pressure Liquid Receiver, Expansion Valve, and Low Pressure Liquid Receiver
    vii. Evaporators
    viii. Primary Refrigeration System Configurations
    ix. Secondary Refrigerant Circuits
    x. Refrigeration Uses in the Brewery

UNIT 6: UTILITIES PART 2

Candidates are required to have an in-depth understanding of the following:

Water

1. Describe the different types of water used in the brewery.
2. Describe the operations within common water treatment processes.

    i. Water Intake and Pre-treatment

3. Compare different water treatment processes.

    i. Raw Water Treatment – Sand and Multimedia Filters
    ii. Raw Water Treatment - Activated Carbon Filters
    iii. Changing Water Composition
    iv. Ion Exchange
    v. Serial Ion-exchange Systems
    vi. Membrane Technology

4. Recommend water treatment options based on different sources and conditions.

    i. Advantages and Disadvantages of Membrane Systems
    ii. Water Disinfection
    iii. Boiler Feed Water
    iv. Overall Water Treatment Solutions

Effluent Treatment

1. Compare aerobic and anaerobic effluent treatment systems.

    i. Primary Effluent Treatment
    ii. Secondary Effluent Treatment
    iii. Anaerobic Effluent Treatment
    iv. Aerobic Effluent Treatment

- v. Combined Anaerobic and Aerobic Treatment
- vi. Tertiary Effluent Treatment
- vii. Other Treatment Options
- viii. Understand the Mogden formula

2. Recommend effluent treatment technologies based on the requirements of a brewery.

   - i. Overall Effluent Treatment and Management

3. Recommend options for water reuse.

Electricity

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1. Describe the basic elements of electricity.

   - i. Basics of Electricity

2. Recommend where in the brewery to use DC and AC power as well as single-phase and three-phase power.

   - i. Direct Current versus Alternating Current
   - ii. Different AC Voltages and Phases
   - iii. Single-phase versus Three-phase Power
   - iv. Electrical Motors
   - v. Power Factor and Power Factor Correction
   - vi. Internal Power Distribution
   - vii. Maximum Demand

3. Explain the differences between earthing, grounding, and overload protection.

   - i. Electrical Safety
   - ii. Electrical Overload

4. Recommend where to use soft starters or VSDs.

   - i. Variable Speed Drives and Soft Starters

Gases

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1. Compare the different methods of generating compressed air.

   - i. Air Compressors
   - ii. Screw Compressors
   - iii. Reciprocating Compressors
   - iv. Blowers

2. Compare the different classes of compressed air and describe how they are relevant for different brewing applications.

   - i. Compressed Air
   - ii. Compressed Air Quality

3. Explain the typical components in a compressed air system.

   i. Removal of Contaminants
   ii. Air Storage, Distribution, and Pressure Control

4. Describe the ways in which oxygen and nitrogen can be supplied, stored, generated, and used.

   i. Oxygen and Nitrogen
   ii. Liquid Nitrogen and Oxygen
   iii. On-site Nitrogen Generation

Carbon Dioxide Recovery Technology

1. Describe and calculate the CO2 production potential of a brew/fermenter in terms of wort volume and original extract (OE).

   i. Carbon Dioxide Quantification
   ii. Carbon Dioxide Production Rate – Multiple Fermenter Room (Block)

2. Calculate the overall collection efficiency of a CO2 recovery plant, over time, against a brewing schedule.

i. Typical Purification Performance and Collection Efficiencies

3. Describe the function of various approaches to switching tanks over from CO2 vent to CO2 collection and suggest their appropriateness for differing sized brewing operations.
4. List the key processes of a recovery plant and their principles of operation.

   i. A High-level View of Carbon Dioxide Recovery
   ii. The Recovery Process
   iii. The Recovery Process and Plant
   iv. De-fobbing – Foam Trap
   v. Balloon Storage
   vi. Washing (Scrubbing)
   vii. Compression
   viii. Deodorising
   ix. Drying
   x. Condensing
   xi. Storage and Vaporisation
   xii. Stripping (Distillation)

UNIT 7: PROCESS CONTROL AND INSTRUMENTATION

Candidates are required to have an in-depth understanding of the following:

Principles of Process Control

1. Explain how the different components within a process control system relate to the different levels of control.

    i. Batch and Continuous Processes
    ii. Process Control Automation Systems
    iii. Process Communication
    iv. The Evolution of Control

2. Compare the different options available for control (PLC/PC/standalone controllers).

    i. Instruments
    ii. Control Elements
    iii. P&ID Symbology

3. Explain the workings of control elements such as pneumatic control valves and VSDs.

    i. Lines
    ii. Valves
    iii. Equipment
    iv. Control Symbols

Process Instrumentation

1. Understand how to apply the factors that influence instrument selection.

    i. Instrumentation Terminology and Selection

2. Describe the principles by which common brewery instruments work and use these principles to evaluate different instruments.

    i. Classification of Instrumentation
    ii. Position Instruments
    iii. Temperature Instruments
    iv. Pressure Instruments
    v. Flowrate Instruments
    vi. Mass Flowmeters

3. Recommend instruments for specific brewery applications.

    i. Vessel Content Measurement
    ii. Analytical Instruments
    iii. Dissolved Gases

Process Control Mechanisms

1. Describe the basic components of a control loop and understand how to apply these to real brewing situations.
2. Compare self-acting, discrete, and continuous control; understand how to apply each of these within different brewing scenarios.

    i. Self-acting Control Mechanisms
    ii. Discrete Control
    iii. Continuous Controllers

3. Explain the principles of PID control and describe how the different components affect the controller response.

    i. Proportional Control
    ii. Integral Control
    iii. Proportional and Integral Control
    iv. Derivative Control
    v. Combined PID Control

4. Recommend process controller configurations for typical brewery applications.

    i. Single Loop Control Configurations
    ii. Multiloop Control Configurations
    iii. Sequence Control

UNIT 8: MATERiALS OF CONSTRUCTION

Candidates are required to have an in-depth understanding of the following:

Classification and Properties

1. Apply material classification to different materials.

    i. General Classification of Materials

2. Understand the different properties of materials.

    i. Properties of Materials

3. Understand the most common forms of corrosion and degradation.

    i. Corrosion
    ii. Forms of Localised Corrosion
    iii. Polymer Degradation

4. Recommend the best welding practices for common materials used in brewing, such as stainless steel.

i. Welding

Materials Application in Brewing

1. Compare the advantages and disadvantages of materials commonly used in a brewery.

    i. Ferrous Metals
    ii. Stainless Steel
    iii. Other Ferrous Metals

2. Recommend the best grade of stainless steel for different brewing applications.

    i. Important Aspects of Stainless Steels

3. Explain why certain materials are used in different applications.

    i. Polymers: Thermoplastics
    ii. Polymers: Thermosets and Elastomers
    iii. Ceramics
    iv. Insulation Materials

Hygienic Design

1. Apply the principles of hygienic design to a brewery.

    i. History of Hygienic Design and Organisations
    ii. Hygiene Organisations
    iii. Components of Hygienic Design

2. Describe what is necessary in order for common processing equipment design to comply with hy gienic requirements.

    i. Materials
    ii. Equipment
    iii. Pipes
    iv. Vessels
    v. In-line Equipment
    vi. Valves
    vii. Installation
    viii. Welding
    ix. Building and Support Structures

3. Recommend how to use organisations to ensure your processing equipment and facility adhere to hygienic design principles.