

Semester III

Course code	Course Title	Credits
Core Compulsory Theory Papers (CCTP)		
WT 3.1	Alcohol Technology-II	4 Credits
WT 3.2	Brewing Technology II	4 Credits
WT 3.3	Enology- II	4 Credits
Core Compulsory Practical Course : CCPP-1		
WT 3.4	Practical Course – I Practical based on alcohol, brewing and wine technology	4 Credits
Choice Based Optional Papers: CBOP (any One)		
WT 3.5	Marketing of alcoholic beverages.	2Credits (Th)
WT 3.6	Practical Course – II	2 Credits (Pr)
		Total 20 Credits

Semester IV

Course code	Course Title	Credits
Core Compulsory Theory Papers (CCTP)		
WT 4.1	Industrial waste treatment & Environmental management	4 Credits
WT 4.2	Business Management	4 Credits
WT 4.3	Chemical and Plant Engineering-II	4 Credits
Core Compulsory Practical Paper : CCPP-1		
WT 4.4	Research Project (Which will be of individuals/groups/Inplant training)	4 Credits
Choice Based Optional Papers: CBOP (any One)		
WT 4.5.1	Alcohol Technology- III	2Credits (Th)
WT 4.5.2	Practical's based on Alcohol technology	2 Credits (Pr)
WT 4.6.1	Brewing Technology- III	2Credits (Th)
WT 4.6.2	Practical's based on Brewing Technology	2 Credits (Pr)
WT 4.7.1	Enology- III	2Credits (Th)
WT4.7.2	Practical's based on Enology	2 Credits (Pr)
Total		20 Credits

Semester III
WT 3.1-Alcohol Technology-II

Credit No.	Credit title	Total hours per credit
3.11	Characteristics of various alcohols, denaturation and by-products of alcohol	15
3.12	Manufacture of Extra Neutral Alcohol, Anhydrous alcohol/Fuel ethanol	15
3.13	Reduction, blending and alcoholic beverages; Making of various traditional beverages	15
3.14	Analytical aspects of alcohol and alcoholic beverages	15
		60

Details of syllabus

Unit	
3.11	<p>Characteristics of various alcohols, denaturation and by-products of alcohol Composition of Wash, RS, EQRS, ENA, EQENA, FA, AA and IS. Denaturation of spirit – Denaturing agents O.D.S, S.D.S., ware house practices – Excise Rules & Regulations. Distillation – Atmospheric distillation process and its operation & maintenance, Specifications of plant and machinery. By products of alcohol manufacture – CO₂, fusel oil & yeast sludge.\</p>
3.12	<p>Manufacture of Extra Neutral Alcohol, Anhydrous alcohol/Fuel ethanol Process details, utilities requirement, specifications of ENA, quality aspect, specifications of plant and machinery. Azeotropic mixture commercial production of ethanol by azeotropic distillation. Distillation efficiency, Effect of traces of entrainer (benzene, cyclohexane, monoethylene glycol) on fuel ethanol. Rules with examples, Maturation and Aging of spirit: Factors influencing alcoholic fermentation.</p>
3.13	<p>Reduction, blending and alcoholic beverages; Making of various traditional beverages Alcoholic beverages-Classification of beverages, liquor, country liquor manufacturing process. Quality control aspects. Global practices for manufacturing of IMFL. Maturation and aging: changes during maturation (spirit characters, aroma, flavor etc). Types of wood used for cask/barrel making. Typical design of barrel, Role of excise department in alcoholic beverages industry. Shelf life of alcoholic beverages. Introduction to making of grain based popular beverages in the world. Indian rice beer (Pachwai), Bhaati Jaanr, Chhang (Lugri, Jhol, Chakti, Ghanti), Themsing, Rakshi, Mingri, Lohpani, Bhangchang, Apong, Sekete, Mhauwa liquor etc.</p>

3.14	Analytical aspects of alcohol and alcoholic beverages Overview of IS and international standards of molasses, various alcohol and alcoholic beverages. Proper sampling of spirit samples for analysis. Introduction to important Global organizations in all over the world involved in analysis of spirit and beverages. Overview of distillery industry in India and world. Importance of thermotolerant and osmophilic yeast in alcohol industry Basic mechanism of thermotolerant and osmophilic yeast, the factors determining and affecting stress of thermotolerance and osmophilic, Industrially important strains for alcohol fermentation and beneficial aspects to industry.
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Reference Book:

1. The Alcohol Textbook – Jacques, T. P. Lyons & D. R. Kelsall
2. Alcoholometry – Satyanarayana Rao
3. Handbook of Fermentation & Distillation – A.C. Chatterjee
4. Distillation – H.C. Barron
5. Technical Excise Manual
6. Byproducts of sugar industry – Paturao

WT 3.2 Brewing technology-II

Credit No.	Credit title	Total hours per credit
3.21	Yeast metabolism and brewhouse technology	15
3.22	Control of brewing process	15
3.23	Packaging and sanitation aspects in brewery	15
3.24	Brewery by - products and waste valorization	15
		60

Details of syllabus

Unit No.	Topic
3.21	<p>Yeast metabolism and brewhouse technology Pure Yeast Cultures: Introduction, strain selection, storage of cultures propagation & scale up, contamination of cultures, Yeast washing, yeast pitching & cell viability, yeast collection, yeast storage, shipping of yeast. Brewhouse Technology: Introduction, General layout of Brewhouse, Heat transfer in the Brewhouse – Heat transfer, materials, Raw Materials Intake: Storage, Removal of foreign objects, Milling: Reasons for milling, Roll mills, Roll milling with conditioning low pressure steam conditioning, Hot water conditioning. Wet milling, wet milling with steep conditioning, Hammer milling, Mash conversion and separation: - Purpose of mashing, Basic principles of mash separation, Mash tuns, mashing – systems, The mash conversion vessel, Adjunct or Cereal Cookers, Mash Kettle, Mash acidification, Mash separation systems – Lauter Tuns, strain mster, mash filters, membrane mash filters, The Nortek Mash filters. Wort Boiling – principles of Boiling, Types of Boiling, Objective, Wort preventing, types of wort boiling systems, Energy recovery systems in the Brewhouse, Hop addition, work clarification – separation systems, wort cooling and Aeration, plate and frame Heat Exchangers. Removal of cold break, cold sedimentation tank, anstellbottich, centrifugation, filtration, floatation, aeration, yeast addition, Brewhouse efficiency – brewhouse yield, Brewhouse capacity, Brewhouse cleaning.</p>
3.22	<p>Control of brewing process Fermentation: Wort: - Clarification, Aeration laboratory analyze, Pitching – Microbial examination, cell concentration and pitching, pitching process. Metabolism & growth – biochemistry of fermentation, growth during fermentation, measurement of growth. Batch fermentations, Lager fermentation, fermentation vessels, characteristics of fermentation, Ale fermentation, Laboratory analysis during fermentation, factors affecting fermentation, yeast strain and condition, pitching rate and yeast growth, temperature, oxygen, zinc,</p>

	<p>trub canny over, fermenter geometry, Related fermentations: High gravity fermentations, accelerated fermentations, High-pressure fermentations, Continuous fermentations, low caloric fermentation:- Definition production methods, Nonalcoholic and low alcohol fermentation – Definitions, major deficiencies, production methods, Immobilized yeast, Abnormal Fermentations – Symptoms causes – process variations , wort nutrient deficiencies yeast changes. Treatments, Beer transfers and yeast separation – yeast cropping consideration, method of cropping – centrifugation, Recovery of carbon dioxide – purity and collection strategies.</p>
3.23	<p>Packaging and sanitation aspects in brewery Packaging Technology: Levels of packaging, packaging materials, packaging and brewing industry, cost of packaging, glass bottles and bottling, bottle filling, PET bottles, cans, Kegs and Kegging, Pasteurization, Tunnel Pasteurization packaging line efficiency. Introduction to CIP. Sanitation and Pest Control: Types of pest encountered, integration of sanitation and pest control methods, possible points of contamination, insects control methods, insect monitoring method, safety.</p>
3.24	<p>Brewery by - products and waste valorization Composition and feed value of major brewery by-products and competitive feeds Brewhouse effluent, spent Hops and Trub. Wet Brewers Grain Handling and Dewatering, Brewers Grain Drying, Brewers grain Feed Products. Brewers yeast Brewers condensed soluble, excess carbon dioxide, spent filter cake. Malt analysis System of analysis of malt, Common analysis –Hot water extract, cold water extract, Moisture content, Distatic power, Dextrinising units, Colour, Fermentable extract, Friability and homogeneity.</p>

Reference Book:

1. American society of brewing chemists, U.S.A.: Methods of analysis of American society of brewing chemists. (8th rev.) U.S.A. American society of brewing chemists, 1996. 1-881696-01-4--(AME)
2. Arntzen,C.J.,ed.: Encyclopedia of agricultural science, vol. 1: - A - D. N. York, Academic Press,1994., Rs.18802.00--(630.3 ARNARN)
3. Birch G.G.: Alcoholic beverages. London, Elsevier Applied Science Pub.,1985., Rs.369.20--(663.1BIR)
4. Government of India.: Technical Excise Manual. --(663.16GOV)
5. Hardwick,W.A., ed.: Handbook of brewing. N.Y ork, Marcel Dekker,Inc.,1995., Rs.6181.50--(663.3 HARHAR)
6. Hough,J.S.,Briggs,D.E.,Stevens,R.,Young,T.W.: Malting & brewing science, vol. 2 : hopped wort & water. London, Champman & Hall, 1982. Rs.591.50- (663.3HOU)
7. Pollock, J.R.A., and ed.: Brewing science vol. 1.London, Academic Press, 1979,

- Rs.7046.80-- (663.3POL)
8. Pollock, J.R.A., and ed.: Brewing science, vol. 2. London, Academic Press, 1981.,
Rs.7046.80--(663.3POL)
 9. Prescott, S.C. & Dunn, C.G.: Industrial microbiology. Jodhpur. Agrobios (India),
2002, 81-7754-149-8.
 10. Priest, F.G.: Brewing microbiology, 2nd ed.. (1996) U.K. Chapman & Hall, 1996.
0412591502--(576PRI)
 11. Priest, Fergus G.; & Stewart, Graham G.: Handbook of brewing. (2nd) U.S.A. CRC
Press, Taylor & Francis Group, 2006. 0-8247-2657 x
 12. Tan S.Harnesey- A History of Beer & Brewing
 13. Stevendeeds Brewing engineering
 14. Michel J. Lewis, Tom W.Young -Brewing
 15. John Palmer -Water a comprehensive guide for brewers
 16. Chris White, Jamil Zaiansheff -Yeast the practical guide to beer fermentation
 17. Johnmallett-Malt a practical guide from field to brewhouse
 18. Stan Hieronymus-Hops

WT 3.3 Enology- II

Credit No.	Credit title	Total hours per credit
3.31	Role of various microbes in enology	18
3.32	Sensory analysis and tasting of wine	10
3.33	Concept of wine parks	12
3.34	Fortified wines	20
		60

Details of syllabus

Units	Topics
3.31	<p>Role of various microbes in enology :</p> <p>Yeast: i)Introduction, isolation & enumeration of wine yeast .Different yeast species/strains used in winemaking ii)Killer yeast –Killer phenomenon, Role of killer yeast in wine making iii)Concept of yeast autolysis ,enological significance of yeast autolysis.</p> <p>Lactic acids bacteria : i) Introduction, isolation & taxonomy of LAB ii) Characteristic of various wine related genera of LAB- <i>Lactobacillus</i>, <i>Leuconostoc</i>, <i>Oenococcus</i>, <i>Pediococcus</i>, <i>Weissella</i>. iii)LAB and malolactic fermentation(MLF)- Deacidification by MLF conversion, Bacteriological stability following MLF, flavor changes from MLF.</p> <p>Acetic acid bacteria : Introduction, isolation & taxonomy of AAB, Acetic acid bacteria in grapes,must,fermentation.</p> <p>Microbiological spoilage of wine & its control: i)Definition of microbiological spoilage ,Origin of wine spoilage microorganism ii)Spoilage by yeast & its control iii)Spoilage by LAB & its control iv)Spoilage by AAB & its control</p>
3.32	<p>Sensory analysis and tasting of wine:</p> <p>Wine tasting- Smell of wine, taste & colour of wine, sensory analysis of wine. Factors affecting on sensory analysis. Sensory analysis profile of white, red and sparkling wine.</p>
3.33	<p>Concept of wine parks:</p> <p>Concept of wine parks recent developments. Wine parks & nodal agencies for establishment of Wine Park in India. Status of wine parks in India with reference to case study. Important wine zones in India.</p>

3.34	Fortified wines : Concept of fortification ,Quality standards for spirit used for fortification Detailed study of sherry wine production - solera system Detailed study of port wine production Detailed study of sweet wine production from noble rot infected grapes
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Reference Book:

1. Handbook of Enology, Vol. I. The Microbiology of Wine and Vinification- P. Ribereau- Gayon, D. Dubourdieu, B. Doneche, A. Lonvaud.
2. American Society for Enology and Viticulture- Seattle.
3. Australian Society of Viticulture and Enology - Andrew Markides, Richard Gibson.
4. Introduction to winemaking, Viticulture and Enology 3- Prof. Ralph E. Kunkee.
5. Understanding wine- Course notes- Patrick Iland, Peter Gago.
6. Wine Science- Ron S. Jackson.
7. Handbook of Enology, Vol 2- The chemistry of wine stabilization and treatments- P. Ribereau – Gayon, D. Dubourdieu, A. Maujean, Y. Glories.
8. Concepts on wine chemistry- the wine appreciation guide- Yair Margalit, James Crum.
9. Wine making from grape growing to marketplace- Richard P. Vine, Ellen M. Harkness, Salley J. Linton.
10. Monitoring the wine making process from grapes to win techniques and concepts- Patrick ILAND, Nick BRUER, Andrew EWART, Andrew MARKIDES, John SITTERS.
11. Wine appreciation- Richard P. Vine.
12. Wine Analysis and production-Brue W. Zoecklein, Kenneth Fugelsang, Barry H. Gump Fred S. Nury (1999)
13. Wine making Basics C. S. Ough (1992)
14. Principles and practices of winemaking-Roger B.Boulton (1996)
15. Knowing & making wine Emile Peynalld (1984)
16. Australian wine from the grapes vine to the glass Patrice Iland& Peter Gago (1997)
17. Wine Analysis and production-Brue W. Zoecklein (1999)

M. Sc.-Part-II-Revised syllabus-1 July2020 M. Sc. (Wine, Brewing & Alcohol Technology)
WT 3.4 Practical (Conduct any 30 practical's)

Sr. No.	Title of practical	No. of practical
1	Determination of residue on evaporation of whisky sample.	1
2	Determination of ethyl alcohol content of whisky by specific gravity method	1
3	To determine the volatile acidity whisky sample.	1
4	Determination of Methyl Alcohol (as CH ₃ OH) content of whisky	1
5	Determination of alcohol content of brandy by densitometer OR hydrometer	1
6	Determination of alcohol content of whisky by densitometer OR hydrometer	1
7	Determination of alcohol content of spirit by densitometer OR hydrometer	1
8	Reduction of the spirit	1
9	Blending of spirit	1
10	Propagation of yeast in laboratory (Demonstration experiment)	1
11	Determination of starch content in grain flour sample.	1
12	Estimation of hop bitterness and colour of beer	1
13	Determination of total plate count of wine	1
14	Detection of microbial contamination in beer	2
15	Quality control aspects of cap, label and bottles of IMFL (2 Practical's)	1
16	Sensory evaluation of wine samples	3
17	Alcohol production from corn/sorghum/sweet potato/molasses	3
18	Brandy production from wine	2
19	Alcohol estimation in wine	1
20	Determination of reducing sugar of wine by Lane and Eynon method	1
21	Making of wine from other than grapes	2
22	Isolation of lactic acid bacteria from wine	1
23	Isolation of wild yeast from wine	1
24	Isolation of acetic acid bacteria from wine	1

3.5 WT Marketing of alcoholic beverages

Credit No.	Credit title	Total hours per credit
I	Basic wine marketing	15
II	Financial management	15
		30

Details of syllabus

Units	Topics
I	1.1 Basic wine marketing 1.1.1 Wine marketing principles 1.1.2 Identify your market category 1.1.3. Basic wine marketing terms
	1.2 Basic of marketing Scotch whisky
	1.3 Marketing opportunities 1.3.1 Opportunities in wine sector 1.3.2 Domestic perspective 1.3.3 International perspective
	1.4 Introduction : Consumer Behaviour and marketing strategies
	1.5 Research of wine ,beer and spirit consumers
	1.6 Buying behaviours.
	1.7 Advertising and promotion management.
II	2.1 Financial Management 2.1.1 Label and bottle design costs 2.1.2 Distribution & marketing costs 2.1.3 Pricing positioning
	2.2 Sales & Distribution channel 2.2.1 Channel of Distribution
	2.3.1 Marketing aspects of wine and brand development Ideal packaging of wine bottle, The question of age, the private wine cellar, serving temperature, decanting wines, which glass for which wine, serving wine, how to open & serve sparkling wines, Corkscrews.

Reference books:

1. Marketing management-Philip Kplte
2. Wine marketing and sales-Paul Wagner, Janeen Olsen, Liz Thach
3. Whisky technology-Production and marketing-Inge Russel
4. Successful wine marketing-Kirby Moulton & James Lapsley
5. International marketing management-P. L. Varhncya & B. Bhattachary
6. Sultan Chand & Sons, New Delhi 110002.

M. Sc.-Part-II-Revised syllabus-1 July2020 M. Sc. (Wine, Brewing & Alcohol Technology)
WT 3.6 Practical Course-II (conduct any 15 practical's)

Sr. No	Title of practical
1	Develop strategy for marketing your own brand
2	Advertising & promotion managements
3	Consumer Buying behavior (Survey)
4	Market forecasting & market segmentation
5	Design an Ecommerce /Digital marketing program of wine/beer/Alcohol
6	Marketing opportunities in wine, beer and alcohol
7	Develop strategy for financial management of your own brand
8	Develop your brand and label – Practical base
9	Bottle Labelling and packaging and promotional activities
10	Design own promotional program to sell your wine,beer or spirit
11	Seminar –I
12	Seminar –II
13	Presentation
14	Case study on industrial analysis report –Any 1(beer ,wine,spirits)
15	Visit to winery/Brewery/Distillery.

Semester-IV

WT 4.1. Industrial Waste Treatment & Environmental Management

Summary

Credit No.	Credit title	Total hours per credit
4.11	Waste generation & characteristics of effluent. IS norms. Biological treatment fundamentals	15
4.12	Winery & brewery sanitization and waste disposal regulations	15
4.13	Waste water disposal systems in industries and air pollution	15
4.14	Water conservation in distilleries	15
		60

Details of syllabus

Unit No.	Title of topic	No. of lectures
4.11	Waste generation & characteristics of effluent. IS norms. Biological treatment fundamentals Waste treatment methods- Types & Selection Criteria, Aeration principles, Aeration & types of system, Composting – microbial aspects & silent features, Economics consideration in composting process, Microbiology & Conversion process in anaerobic fermentation, Kinetics of methane fermentation. Energy generation and types of anaerobic system, Incineration – Theoretical, considerations, types, incineration systems in practice, Type of secondary treatment system.	15
4.12	Winery & brewery sanitization and waste disposal regulations Winery sanitization- The Importance of Cleaning and Sanitation in the Winery, Basic Cleaning, Water Quality, The Solution: Cleaning Compounds, Cleaning Equipment, Sanitizing and Sanitizers, Sterilizing and Sterilizers, Hardware: Tanks, Pumps, Hops, Walls, Floors, Ceilings, Drains, Solid and Liquid Waste Disposal, Government Regulations, Safety, OSHA, EPA, DNR, MSDS, Sanitation Plan.	15
4.13	Waste water disposal systems in industries and air pollution Waste Beer, solid waste materials, wastewater disposal and treatments. Sludge treatment, Disposal and Utilization, Land application of Brewery Effluents, Production of single cell protein from Brewery Effluents. Air pollution: Air pollution control principles & equipments, Environmental Audit, Disposal of effluent & soil fertility, Environmental laws, Case studies.	15

4.14	<p>Water conservation in distilleries.</p> <p>Requirement of total water for process and non-process in typical 30 KLPD molasses and grain based distillery. Scope for water recycles of various streams for process. Cost economics of saving of water in distillery with typical case study. Importance of water conservation in distilleries.</p> <p>Concept of 3R System</p> <p>CREP norms, Define Zero liquid discharge (ZLD), Existing effluent treatment technologies for achieving ZLD in molasses and grain based distilleries as approved by Ministry of Environment & Forest and Climate Change (MoEF & CC) and Central Pollution Control Board. Importance of environmental clearance, Consent to establishment and consent to operate, Characteristics of spentwash generated in molasses based distilleries and whole stillage generated in grain based distilleries, Various polluted and non-polluted waste generated in distilleries; Its quantity and mode of disposal (solid/liquid/gas), Technologies for treatment of low strength waste generated in distilleries, Condensate polishing unit (CPU), Reverse osmosis; Environment norms for disposal of effluent on land.</p>	15
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Reference Books:

1. T.D. Brock, Biology of Microorganisms.
2. Introduction of Waste water treatment R.S. Ramalho.
3. C.A. Edwards & G.U. Veeresu “Soil Biology & Ecology in India”, Published by University of Agricultural Sciences, Hebbal, Bangalore, 1978.
4. R.K. Trivedi, Environmental and Industrial Pollution control. Vol. I
5. Technical EIA guidance manual for distilleries-Ministry of Environment & Forest, Govt. of India-September 2009.
6. Management of Distillery Wastewater-Central Pollution Control Board, Ministry of Environment & Forest, September2001

WT 4.2. Business Management: (BM)
Summary

Credit No.	Credit title	Total hours per credit
4.21	Business Management and Communication in Wine, Brewing & Alcohol Industry	15
4.22	Operations Management	15
4.23	Financial management	15
4.24	Marketing Management & Buying Behavior	15
		60

Details of syllabus

Units	Topics	No. of lectures
4.21	<p>Business Management and Communication in Wine, Brewing & Alcohol Industry:</p> <ul style="list-style-type: none"> i. Principles of Management ii. Business Communication and soft skills iii. Financial Accounting iv. Economic Environment of Business preneurship Development 	15
4.22	<p>Operations Management:</p> <ul style="list-style-type: none"> i. Process Management:Explores how to Organize for production e.g. the design and development of products, forecasting demand, planning capacity Plant location and layout, production systems, process design and technology ii. Production ManagementThe people factor in production. Management: personnel, costs, investment and automatization iii. Integral Quality/Assurance and ISO 9000 <ul style="list-style-type: none"> 1. Microbiology control 2. Physicochemical analysis of raw material, intermediate and final product Hygiene, cleaning, disinfection, and pasteurization. 3. Wastewater treatment Off-plant beer treatment: transport, storage and serving of beer. iv. Product development: low alcohol beers, diet beers (light beers) etc 	15

M. Sc.-Part-II-Revised syllabus-1 July2020 M. Sc. (Wine, Brewing & Alcohol Technology)

4.23	<p>Financial management:</p> <p>i. Financial management and Financial analysis: Definition, objectives, functions & scope. Details of financial analysis and management.</p> <p>ii. Financial control & management information system: Definition, objectives, functions & scope. Funds flow analysis, Ratio analysis, Cost profit volume analysis.</p> <p>iii. Analysis of financial parameters for setting up of industry & its appraisal report.</p> <p>iv. Maintenance Management, Inventory planning and Inspection Importance and types of maintenance, spare part maintenance and concept of TPM. Inventory planning and control, E.O.Q and numerical on E.O.Q.Inspection: Cent percent Inspection, Random Sampling, Introduction to Six Sigma, Seven tools of quality control.</p>	15
4.24	<p>Marketing Management & Buying Behavior</p> <p>i. Definition of Marketing Management</p> <p>ii. Importance and Function of Marketing Management</p> <p>iii. Buying Motives</p> <p>iv. Importance of Studying Buying Behavior</p> <p>v. Factors Influencing Buying Behavior</p> <p>vi. Buying Decision Process</p> <p>Case Study</p> <hr/> <p>Patents</p> <p>i. Concepts of Patent</p> <p>ii. Composition of patent</p> <p>iii. Patent Indian and International Standard</p>	15

Reference books:

1. Operation and supply of chain management-Vijay Gaikwad, Pushkar Aurangabadkar
2. Production and operation management-Prof. J. P. sexana
3. Total quality management-Prof. R. S. Nagarjun
4. Operation and supply chain-Dr. E. B. Khedkar, Dr. A. B. Ingale
5. Product design and development-Karl T. Ulrich, Stebend Eppinger

M. Sc.-Part-II-Revised syllabus-1 July2020 M. Sc. (Wine, Brewing & Alcohol Technology)
WT 4.3 Chemical & Plant engineering –II
Summary

Credit No.	Credit title	Total hours per credit
4.31	Mass balance and Separation techniques	15
4.32	Heat transfer	15
4.33	Pumps and their applications	15
4.34	Fluid mechanics	15
		60

Details of syllabus

Unit No.	Title of credit
4.31	<p>Mass balance and Separation techniques Single and multiple unit processes, Reactive systems, Purge systems, Recycle, Bypass systems. Separation techniques like sedimentation, filtration & centrifugation: basic principle & equipment. Membrane separations & their applications.</p>
4.32	<p>Heat transfer Conduction, convection, thermal resistance and heat flux, Types of heat exchangers, Nucleate boiling curves, calculation of boiling heat flux, Vapor compression, Heat efficiency, Heat transfer through flat and curved surfaces and effects of insulation and its efficiency.</p>
4.33	<p>Pumps and their applications Pumps and their applications, characteristic curves, types of pumps, (maintenance of pumps and operation). Use of compressed air for process industry, compressor and its working principles. Fluid flow fundamentals. Laminar and turbulent flow. Bernoulliz theorem and its applications, Friction factor pump selection and applications.</p>
4.34	<p>Fluid mechanics Energy balances specific and latent heat, Enthalpy, Entropy, Internal energy heat and work, Open and closed systems, Thermodynamic diagrams, power and refrigeration. Fluid static, fluid dynamics, flow measurement, pipe/duct flow. Frictional pressure losses in pipe/duct, flow pumps/fans, cavitations. Design of distillation column Calculation of number of plates using McCabe Thoiale method. Design of distillation column. Industrial Automation:</p>

M. Sc.-Part-II-Revised syllabus-1 July2020 M. Sc. (Wine, Brewing & Alcohol Technology)

<p>Introduction, Terminology related to Automation, Benefits, Basics of PLC, SCADA and DCS.</p> <p>Control System Components:</p> <p>Control valves: Valve coefficient, types & selection, Actuator types, Positioner, I to P converters, Smart D.P. transmitter, Controller types.</p> <p>Psychometric</p> <p>Heating, cooling, humidification, dehumidification, mixing of air streams, drying of cereals and food as psychometric process.</p>

Reference Books:

1. Mass Transfer Operations – Robert E. Treybal
2. Introduction to Chemical Engineering – Ghosal&Sanyal
3. Unit Operations of Chemical Engineering – Warren L. McCabe, Julian C. Smith
4. Process Heat Transfer- D. Q. Kern
5. Process control systems by F.G. Shinskey
6. Process Control Instrumentation Technology by C. D. Johnson.
7. Applied Instrumentation in the Process Industries by W.G. Andrew and H.B. Williams

WT. 4.4 Short term research project (Individual/groups) OR In plant training in industry.

The Opportunity to analyze a particular industry based problem or topic in depth. Conduct a relevant lab or library- based study. To provide a chance to improve fundamental research & analysis, skills & advance understanding of then processes involved in Wine technology, Brewing technology or Alcohol technology. Student has to undertake an extended investigation in an advanced topic of relevance to their degree discipline or to their Sponsoring industrial partner. The research project builds on the taught modules of the course. Students should analyses their results & present the same in the form of a dissertation that includes a review of previous research & set their work in context with critically argued discussion. Students should contribute via seminars or posters or publication to the research activity of the host /work institution.

WT 4.5.1 Alcohol Technology-III
Summary

Credit No.	Credit title	Total hours per credit
4.5.11	Fed batch/Continuous fermentation	15
4.5.12	Multipressure distillation and Molecular sieve dehydration system.	15
		30

Details of syllabus

Unit No.	Details of credit	No. of lectures
4.5.11	<p>Fed batch/Continuous fermentation Theoretical aspects of continuous fermentation, various types of continuous fermentation systems, continuous Vs Batch Fermentation Systems. Single Fermentation Continuous System (Biostil), Process Details with floe diagrams, Operational aspects, details of plant & machinery. Merits & demerits of the technology, Cascade continuous Fermentation system,, Process details with flow diagram, operational aspects, details of plant & machinery, merits and demerits of technology, Yeast Flocculation Continuous Fermentation System (Encillium -NCL), Process details with flow diagram, operational aspects, details of plant & machinery, Merits & Demerits of technology, Evaluation of Continuous fermentation Technologies. Dry & wet gauging of tanks. Contamination control with special reference to continuous fermentation process.</p> <p>Alcohol from Non-molasses sources, manufacture of malt alcohol and cost of production of alcohol Characterization of various non-molasses sources for alcohol production. Process details of alcohol production from Corn, Sweet Sorghum, Tapioca , Sugarcane Juice and others, Quality aspects of alcohol from non- molasses sources, Production of alcohol from non-molasses sources in the existing molasses based distillery. Manufacture of liquors-Rum, Whisky, Gin, Vodka, brandy, Cachaca, Taquilla etc. & bottling, packing of liquors. Reduction & blending of spirit. Blending and sensory analysis of various spirit and liquors. Details of production of malt alcohol. International scenario of alcohol production and potential for import and export. Typical cost of production of alcohol. Pot distillation, Difference</p>	15

M. Sc.-Part-II-Revised syllabus-1 July2020 M. Sc. (Wine, Brewing & Alcohol Technology)

	between pot distillation and conventional distillation.	
4.5.12	<p>Multipressure distillation and Molecular sieve dehydration system. Mechanism, flow diagram and concepts behind Molecular sieve and MPR distillation. The quality aspects of spirit using MPR distillation.</p> <p>Importance of Spectroscopic and chromatographic techniques in alcohol industries Introduction to various spectroscopic and chromatographic techniques useful for alcohol industry. Role of GC-MS, GC, HPLC, HPTLC and other sophisticated instruments in analysis of molasses, fermented wash, RS, ENA, AA, SDS, beer, wine and various beverages.</p>	15

Reference Book:

1. The Alcohol Textbook – Jacques, T. P. Lyons & D. R. Kelsall
2. Alcoholometry – Satyanarayana Rao
3. Handbook of Fermentation & Distillation – A.C. Chatterjee
4. Distillation – H.C. Barron
5. Technical Excise Manual
6. Byproducts of sugar industry – Paturao

WT 4.5.2 Practical (Conduct any 15 practical's)

1. To determine the reducing sugars in the given molasses sample
2. Determination of total sugar as invert sugar in given molasses sample
3. Determination of volatile acids of molasses
4. Conduct lab trails of molasses/starch based fermentation
5. Estimation of acidity in molasses fermented broth
6. Estimation of residual sugar in molasses fermented broth
7. Estimation of alcohol content of in molasses fermented broth
8. Estimation of volatile acids in molasses fermented broth
9. Determination of sludge content of molasses
10. Determination of calcium content of molasses
11. Microscopic observation of alcoholic fermented wash
12. Estimation of caramel content of molasses
13. Determination of mesophilic bacteria of molasses
14. Determination of slime forming bacteria of molasses
15. Determination of yeast & molds of molasses
16. Determination of thermophilic bacteria of molasses
17. Determination of wild yeast of molasses.
18. Demonstration of fermentation and distillation processes at distillery site (3 Practicals)
19. Sensory evaluation of IMFL samples (2 Practicals)

**WT 4.6.1 Brewing Technology-III
Summary**

Credit No.	Credit title	Total hours per credit
I	Beer types and their special features	15
II	Bottling/canning the beer	15
		30

Details of syllabus

Unit No.	Details of unit
I	<p>Beer types and their special features Beers Produced by top & bottom Fermentation, Special features of top fermentation, Physiological differences between top fermenting yeast & Bottom fermenting yeast. Assessing yeast Viability, Yeast Viability tests, Yeast Vitality test. Measures of cellular activity, Flurometric Vitality test, Saccharomyces wild yeast, Non Saccharomyces Wild yeasts, Biofilms, Controlling contamination.</p> <p style="padding-left: 40px;">Aging and Finishing: Introduction, Objectives of Aging and Finishing, component processes flavor maturation: - Impart flavor compounds Diacetyl and 2, 3-pentanedione, sulfur compounds, non-volatile flavor maturation, yeast autolysis Lagering and secondary fermentation (Kransening) Historical Lagering Practice, Krausening, lagering without secondary fermentation, addition of modified Hop extracts. Beer Recovery: Economics, Quality of recovered beer. Clarification: - Gravity sedimentation, finings, filtration, filters, sterile filtration. Stabilization: Beer Stability: Biological and Non-biological Instability. Biological Instability, Non biological stability: Physical stability, Flavor stability foam stability, Gushing, light stability, Flavor stability, Biological stability, Physical stability, Carbonation: - Basics of beer carbonation, modern carbonation, Standardization.</p>
II	<p>Bottling/canning the beer Advantages & disadvantages of glass bottles, Glass Bottle Production, Shape Color, Surface coating, Scuffing, Bottle after. coating filling & cleaning of returnable glass bottles, Factors Which influence bottle washing, Design of Bottle washing Machine, Single end, Double end washing Machines, Cleaning & Maintenance Work on Bottle Washing Machine Control of filling process, Closing the Bottles, pasteurizing in bottles, Labeling & foiling the bottles, PET.</p>

M. Sc.-Part-II-Revised syllabus-1 July2020 M. Sc. (Wine, Brewing & Alcohol Technology)

<p>Bottles, plastic screw cap closures, Filling of wooden barrels & Casks. Secondary contaminants, beer dispensing.</p> <p>Micro/Pub brewing</p> <p>Micro Brewers, Hobby brewers, making your own malt. Pub breweries. Plant & Process diagram of pub breweries. The concept of home brewing, The details of home brewing, availability of raw materials kit and basic equipments, Precaution and quality measures for home brewing, Home brew maturation, Fermentation & Maturation cellar, Dispense equipment. Energy Supplies, Legal Regulations.</p>

Reference Book:

1. American Society of Brewing Chemists, U.S.A.: Methods of analysis of American society of brewing chemists. (8th rev.) U.S.A. American society of brewing chemists, 1996.
2. Arntzen,C.J.,ed.: Encyclopedia of agricultural science, vol. 1: - A - D. N. York, Academic Press, 1994.
3. Birch,G.G.: Alcoholic beverages. London, Elsevier Applied Science Pub.1985.
4. Government of India. Technical Excise Manual. --(663.16GOV)
5. Hardwick,W.A.,ed.: Handbook of brewing. N. York, Marcel Dekker,Inc.,1995.(663.3 HARHAR)
6. Hough,J.S.,Briggs,D.E.,Stevens,R.,Young,T.W.: Malting & brewing science, vol. 2 : hopped wort & water. London, Champman & Hall, 1982.
7. Pollock, J.R.A., and ed.: Brewing science vol. 1.London, Academic Press, 1979, (663.3POL)
8. Pollock, J.R.A., and ed.: Brewing science, vol. 2. London, Academic Press, 1981. (663.3POL)
9. Prescott, S.C. & Dunn, C.G.: Industrial microbiology. Jodhpur. Agrobios (India), 2002. 81-7754-149-8
10. Priest, F.G.: Brewing microbiology, 2nd ed.. (1996) U.K. Chapman & Hall, 1996. 0412591502--(576PRI)
11. Priest, Fergus G.; & Stewart, Graham G.: Handbook of brewing. (2nd) U.S.A. CRC Press, Taylor & Francis Group, 2006.
12. Tan S.Harnesey- A History of Beer & Brewing
13. Stevendeads Brewing engineering
14. Michel J. Lewis, Tom W.Young -Brewing
15. John Palmer -Water a comprehensive guide for brewers
16. Chris White, Jamil Zaiansheff -Yeast the practical guide to beer fermentation
17. Johnmallett-Malt a practical guide from field to brewhouse
18. Stan Hieronymus-Hops

WT 4.6.2 Practical (Conduct any 15 practical's)

1. Estimation of protein content of barley by suitable method
2. Estimation of moisture content of malt
3. Estimation of total acidity of beer
4. Estimation of free amino nitrogen of wort.
5. Estimate color ,bitterness of wort
6. Estimation of reducing sugar of beer
7. Estimation of alcohol content of beer
8. Estimation of protein content of wort by suitable method
9. Differential staining of wort and beer
10. Estimation of °Brix of wort
11. Starch Conversion Test for mash or wort
12. Determine pH, total alkalinity, hardness, chloride and TDS of water used for beer production.(2 practical's)
13. General culture media for isolation of bacteria from beer
14. Differential culture media for isolation of bacteria from beer
15. Isolation of wild yeast from beer
16. Estimation of yeast solids by total dry weight method
17. Pre-bottling operations of beer
18. Quality control aspects of finished beer
19. Sensory evaluation of beer (2 practical's)
20. Study off flavors present in beer
21. Demonstration of yeast propagation for beer
22. A Indian beer brands : A Case study

**WT 4.7.1 Enology-III
Summary**

Credit No.	Credit title	Total hours per credit
I	Post fermentation treatments of wines & related topics	15
II	Maturation and aging of wine	15
		30

Details of syllabus

Units	Topic
I	<p>Post fermentation treatments of wines & related topics :</p> <p>i)Concept of clarification & stability of wine Study of various clarification & stabilization techniques – cold stabilization ,filtration , Racking, ion exchange, electrophoresis , fining etc</p> <p>ii)Tartrate stability –detailed concept ,methodology for estimating cold stability & its control</p> <p>ii)Protein stability –detailed concept ,methodology for estimating protein stability & its control</p> <p>iii)Metallic casse – ferric casse ,cupric case</p> <p>iv)Fining – Principle of fining ,Aim of fining ,detailed study of various fining agents used in enology ,effect of overfining.</p>
II	<p>Maturation and aging of wine</p> <p>Objectives of maturation. Containers/cooperages for maturation. Factors affecting maturation of wine. Chemical reactions occurring during wine ageing. Extraction of phenolic compounds from Oak.</p> <p>Bulk Wine & bottled wine storage : Managing ullages headspace, Temperatures of bulk wine storage, bottled wine storage – stacking method, temperature, light and humidity</p> <p>Blending and bottling of wine:</p> <p>Reasons/necessity for blending of wines. Various precautions/rules taken in to consideration during blending of wine.</p> <p>Bottle cleaning/hygiene measures. Bottling lines and environment. Bottling and corking: Wine bottle closures. Considerations and requirements for glass containers for packaging (Dimensions, volume, homogeneity, Annealing, Thermal shock test etc). Various bottling operations -Quality control, bottling room, dedusting and rinsing of bottles, filling, cork insertion, labeling, capsulation and foiling etc.</p> <p>Wine Defects : Oxidation : acetaldehyde, acetic acid, ethyl acetate Sulfur compounds: sulfur oxides, hydrogen sulfide, mercaptans, dimethyl Sulfide</p> <p>Study of various practical techniques to solve defects during processing –phenolic wines-harsh and drying tannins, deacidification, acidification, dealing with stuck fermentation</p>

Referance Book-

1. The Production of Grapes & Wine in cool Climates. David Jackson & Danny Schuster
2. American Society for Enology & Viticulture 50th Anniversary Annual Meeting
June -19-23-2000 Washington State Convention & Trade Linter Seattle, Washington
3. Methods for analysis of musts & wines- IInd Edition C.S.Ough & M. A. Amerine.
4. Understanding Wine Technology-David Bird
5. Practical aspects of Wine Filtration-Bernard Gautier.
6. Better Wines from Concentrates-T. Edwin Belt
7. Wine Marketing & Sales-Success Strategies for a Saturated market-Paul Wagner, Janeen olsen
Liz Thach.
8. Wine for Women-Leslie Sbrocco.
9. Hand Book of Enology-Vol-I The Microbiology of Wine & Verification- P.
Rebereau Gayon.D. Dulubourdieu, B. Doneche, A.Lonvauel
10. American Society for Enology & Viticulture-Seattle
11. Australian Society of Viticulture & Enology-Andrew Markides Richard
Gibson.
12. Introduction to Wine Making Viticulture & Enology Prof. Ralf A.Kunkee.
13. Understanding Wine Course Notes Patric II & Peter Gago
14. Wine Science- Ron S. Jackson
15. Hand Book of Enology-Vol.2-The Chemistry of Wine Stabilization & treatments- P.
Rabereau, Gayon D.Dalabourdieu, A. Maujean, Y. Glories.
16. Concepts of Wine Chemistry-The Wine appreciation Guide-Vair Margalit, James Cram.
17. Wine Making From Grape growing to Market Place Richard P. Vine, Elie
Harkness. Salley J. Linton
18. Monitoring the Wine Making Process From grapes to wine techniques & Concept- Patric I
Land. Nick Bruer, Andrew EWART. Andrew Markides John Sitters.
19. Wine Appreciation-Richard P. Vine

WT 4.7.2 –Practical (Conduct any 15 practicals)

1. Determination of methanol content of wine.
2. Pre operations of wine bottling –Details of quality measures
3. Demonstration of filtration of wine
4. Demonstration of bottling of wine
5. Assess and conduct fining trails of bentonite on wine.
6. Assess and conduct fining trails of PVPP on wine.
7. Assess and conduct fining trails of Gelatin on wine.
8. Assess and conduct fining trails of egg albumen/egg white on wine.
9. Conduct heat stability test for protein stability in wine(2 practical's)
10. Conduct cold stability test for tartrate stability in wine(2 practical's)
11. Detect iron haze & copper haze in given wine sample
12. Determine SO₂ of given wine by aspiration method.
13. Perform oxidative test for red wine.
14. Determine microbiological stability test of given wine sample
15. Determine carbon dioxide content of given wine sample
16. Quality control aspects of packaging materials of wine bottles
17. Perform matching wine with food
18. Assess and conduct blending trail of wine.
19. New techniques in wine production world: A case study