**Syllabus of M.Sc. (WT) Sem- III & IV**

**Semester - III**

**(WT 3.1) Alcohol Technology II**

**Section I**

1. Distillation theory pot & continuous distillation, Control of congener levels, spirit maturation, Relative volatility & liquid vapor equilibrium diagrams, Daltons, Raoult’s & Henry laws
2. Azeotropic mixtures –minimum & maximum boiling, Top & bottom operating lines Lewis Sorel & Mc Cube Thiele method for calculating theoretical plate’s extractive distillation.
3. Q line & feed condition calculation, Reflux ratio minimum & total reflux calculation, Types of plate & plate efficiency, Heat loss by convection & radiation from stills.

**Section II**

1. Cereal cooking energy calculation, CO₂ recovery, Dark grains processing, Effluent treatment, anaerobic & aerobic digestion, cooperage.
2. Warehouse & maturation, Wood chemistry & physical changes during maturation, flavor evaluation of remake & mature spirits.
   Co₂ /dark grain recovery, Cooperage wood chemistry, Chemical charges during distillation & maturation of whiskey. Flavor of Scotch whisky.
3. Various aspects & production of distilled beverages other than Scotch whisky as well as blending, Packaging & marketing of beers & whisky.

**Reference Books-**

2. *Alcoholometry-Satyanarayana Rao*
3. *Hand Book of Fermentation & Distillation –A.C. Chatterjee*
5. *By Products Of Sugar Industry- Paturao*
6. *Whisky Technology,Production & Marketing -Inge Russell*
Section I

1. The Brewing Process from posh mashing to fermentation vessel/wash back effect of boiling on wort composition. Fermentation difference between brewery & distillery worth, osmotic effects, yeast sensing system. Beer & Spirits processes
3. Biology of yeast, principles of fermentation, Biochemistry of fermentation & Kinetics of fermentation. Production of beer flavor compounds during Fermentation, Solid-liquid separation, processing of wort to bright beer
4. Sensory analysis of Beer.

Section II

1. Detection of yeast quality, Detection of microbiological contamination of raw material, wort, beer & yeast culture.
2. Use of pilot brewing plant, packaging & dispense, brewery effluents.
5. Craft of Artisan Distiller of Whiskey Distillation Preface, Introduction
   1) Distillation Principles
   2) Mashing
   3) Distilling Procedures
   4) Barrel aging
   5) Bottling
   6) How to Make Moonshine
Reference Book-

1. *Brewing Science (Barley to Beer)*
2. *Brewery Engineering: Physical Principles in Brewing*
3. *Brewing Science: Linkages and Relationships*
5. *American Society of Brewing Chemists USA-Method of analysis of American Society Of brewing chemists (8\textsuperscript{th} rev.) USA American Society of brewing chemists 1996 1-88 ,1696-01-4 (AME)*
9. *Industrial Microbiology. Prescott S.C. & Dunng Jodhpur Agro bios (India) 2002. 81-7754-149-8*
13. *Brewing Microbiology -2\textsuperscript{nd} Ed 1996 UK Priest FG Chapman & Hall 1996 0412591502(576 PRI)*
15. *Government of India Technical Excise Manual (663.16 Gov.)*

WT.3.3 Enology II

Section I

1. Red Wine vinification- Red wine styles, Grape Cultivars (Morphology, Ampelography) Maceration types, Pinot Noir style, cabernet style, merlot, syrah style, filtration, Fining.
2. Sweet wine making- method of berry sugar improvements, late harvest, botrytis, Tokage aszu style, St.croix du mont ,Ice wine, curio extraction, passion & renato style
Disadvantages of glass bottles, Bag -in –box, Pet bottles, Different closers (Cork, Screw cap, Vivo Seal, Zork, Crown) Pre-treatments before bottling.

Section II

1. Wine appreciation – Wine Producing Regions of the world New-(USA, Canada, Australia, New Zealand, South America, India, South Africa) Old- (France, Italy, Germany, Spain, Portugal, Austria)

2. Sensory Evaluation of wine- Terms, Methods, uses, factors influencing tasting, Formal &Informal tasting, 3Noses of Wine, Service temp

3. Case Study on indigenous wines- Cava, Spumante, Sekt, Chianti, mulled wine, Russian shamanoski, Cap classique, Claret & Clarret.

4. Maturation & aging II- Bottle Bouquet, Bulk Maturation, Chemical Changes in wine, Time-Temp relationship

5. Quality assurance & Quality control

6. Composition of wine & faults of wine-Environmental & Microbial defects

Reference Book-


2. American Society for Enology & Viticulture –Seattle


4. Introduction to Wine Making, Viticulture & Enology 3 Prof. Ralph E. Kunkee.

5. Understanding Wine Course Notes- Patrick II & Peter Gago.

6. Wine Science-Ron S. Jackson


9. Wine Making From grape growing to market place Richard P. Vine, Elien M.Harkness, Salleg J. Linton

10. Monitoring the wine making process from grapes to wine techniques & concepts- Patrick I Land, Nick BRUER, Andrew E Wart, Andrew Markides John Sitters.

(WT 3.4) Chemical & Plant Engineering II

Section I

1. Mass Balance- Single unit processes ,Multiple unit processes ,Reactive systems , Purge systems , Recycle , Bypass systems

Section II

2. Psychometric- Heating, cooling, humidification, dehumidification, mixing of air streams. Drying of cereals & food as psychometric process.

Reference Book-

1. Introduction to Chemical Engineering –Badger & Baneo
2. Introduction to Chemical Engineering-Ghosal & Sanyal
3. Stoichiometry- Bhatt & Vora

(WT. 3.5) - Practical I

1. Determination of wort Composition
2. Kinetics of Fermentation
3. Solid Liquid Separation
4. Sensory analysis of beer
5. Detection of Microbiological contamination in raw material & wort
6. Detection of Contamination in Beer
7. Designing flavor evaluation test carrying flavor Evaluation & Analysis of Beer
8. Studies on Filtration & fining of Red Wine
9. Making of Sweet Wine
10. Sensory evaluation of Wine
11. Pot Distillation of Fermented Beer
12. Blending of Beer
13. Studies on wood Chemistry & physical changes during Maturation
14. Detection of yeast quality & ferment or efficiency
15. Studies on Osmotic effects & yeast sensing system
16. Studies on Bottles & new trends in Containers & corks
17. Studies on Botrytis infected grape wines
18. Maceration of berries & their analysis Studies on Raw material specifications, Quantities & processing parameters in beer making process
19. Studies on brewery effluents – Chemical & Microbiological Analysis
20. Analysis of Final Products - Beer & Whisky
Semester –IV

(WT 4.1) Business Management

Section I

1. Operations Management:
   Operations: explores the concept of operations and operations management, briefly exploring their history and strategic importance and setting present day practice in the company, local and international contexts.

2. Operations Management:
   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, The people factors in production, Management: personnel, costs, investment and automatization for integral Quality/Assurance and ISO 9000
   1) Microbiology control
   2) Physicochemical analysis of raw material, intermediate and final product

Hygiene, cleaning, disinfection, and pasteurization. Wastewater treatment

Off-plant beer treatment: transport, storage and serving of beer.

Product development: low alcohol beers, diet beers (light beers), special Types of beer (for example bottle referenced beer)

3. Operations Management:
   Performance Improvement: examines the need for improvement method. And how performance may be measured.
   range of strategies and techniques to improve both individual Performance and organization-Wise Productivity.

Reference Book-

1. International Marketing Management (An Indian Perspective) 1999 Sultan Chand & Sons New Delhi-11002
3. Marketing Management- Philip Colar
4. Marketing Management-Sherlekar S.A.
5. Export Marketing of Indian 1985-University of Delhi New Manufacturers
6. Modern Business Organization-S. A.Sherlekar
Section II

1. Production Management: Quality: is concerned with precisely what is meant by product and service Quality in different business contexts. How quality has been managed through the years including current topics such as business excellence.

2. Production Management: Supply Chain Management: looks at What A supply chain is and What Partnering is. Basic concepts in Planning, scheduling And materials management (e.g. improvement tools and techniques, Planning and controlling, scheduling, inventory management, Purchasing/ buying, just-in-time, supplier/ buyer relationships, quality management, reliability, safety and Maintenance. Discussion of logistics including Warehousing and distribution Which is IIIustrated by a further case study.

3. Marketing: Discusses the activities performed by marketing managers Organization of marketing function The factors that influence marketing and different marketing strategie.

4. Human resource Management: Functions of HRM How it is used to bring predictability, Reliability and control to a business.

5. Business Accounting: Activities Involved in business accounting & finance
Introduction, Conceptual Frame Work, Recording, Transaction Preparation of Final accounts, Introduction to Company Final Accounts, Computerized Accounting

6. Case Studies: Case studies illustrating the various aspects and production management are presented

(WT. 4.2) Industrial Waste treatment & Environmental Management.

Section I

1. Waste treatment: - Waste Water Composition, Characters, Type of Wastes
   Solid Liquid Gases Mixture, Waste water treatment, objective & regulations,
   waste water treatment plant design.
2. Physical Unit Operations- Flow measurement, screening, flow equalization,
   Mixing sedimentation, Accelerated gravity Separation, Granular medium filtration,
   Gas transfer, Volatilization & Gas stripping of volatile organic compounds.
   Chemical precipitation, Adsorption, (Biosorption) Disinfection, Dechlorination,
3. Biological unit processes- Aerobic, Anaerobic digestion Denitrification
   Removal of Phosphorus, toxic compounds & refractory organics, Removal of
   dissolved inorganic substances.
   Sludge treatment & disposal, In situ bioremediation, Design Principle & designing
   of ETP. Troubleshooting, Environmental Impact Assessment.(E.I.A.)
4. Nuclear Hazards:- Nuclear Accidents & Holocaust, Environmental Legislation in
   India

Section II

1. Solid Waste Management- Typical classification, Sources of industrial waste,
   Agricultural waste, Disposal methods ,Hazardous waste, Treatment Methods,
   Biomedical wastes Solid Waste of breweries as cattle feed & other by products
2. Water treatment :- water cycle, water environment , Drinking water, waste water
   collection ,Waste Water treatment ,Groundwater
3. Noise Pollution: Causes & control measures
4. Nuclear Hazards:- Nuclear Accidents & Holocaust, Environmental Legislation in
   India

Reference Book-

1. Industrial Microbiology-Patel
2. Biotechnology - B. D. Singh
4. Introduction to Environmental Awareness - Dr. Prasanna P. Sethy
5. Fermentation technology - M. L. Srivastava
6. Industrial Microbiology - L. E. Casida
7. Hand book on Fertiliser technology - The Fertiliser Association of India New Delhi-110067

(WT 4.3) Alcohol Technology III


Section-II

5. Whisky Analysis- Whiskey’s of World & their regulatory definitions- Scotch Whiskey, Scotch Whisky order 1990

European union regulations, Irish Whiskey, American Whiskey, Canadian Whisky, Bourbon Whiskey, Rye Whiskey, Corn Whiskey, Light Whiskey, Tennessee Whiskey.
Alcoholic Strength Measurement, Major Volatile Congeners, Trace congener, Maturation Congeners Whisky age, PH, Residue, Ash Anions & Cations, Volatile Phenolic congener & Sensory analysis Quality assurance & analysis in Whiskey Production, Process Malting, Fermentation, distillation & maturation, Blending & bottling, Whiskey Stability Off odours as Contaminants in Whisky, Brand & Generic Authenticity


Reference Book-
2. Alcoholometry- Satyanarayana Rao
3. Hand Book of Fermentation & Distillation- A. C. Chatterjee
5. By Products of Suger Industry- Paturao
6. Whiskey Technology, Production & Marketing- Inge Russel
7. Malt Whisky- Chales Mc Lean

(WT 4.41) CHEM-CAD design(CCD)

Section I

1. Introduction:–
   a) Modeling and simulation as a design procedure and be able to apply this method to a wide range of problems.
   b) Analytical techniques for structural systems, system dynamics and thermo-fluid systems.
   c) Introduction to geometric modeling technology and associated computational geometry. A study of data exchange issues related to analysis and simulation.
2. Computer aided Modeling:–
Modern features-based modeling system for the purposes of designing an assembly and use this geometry as the basis for analysis and simulation, utilizing available data exchange mechanisms.

3. Finite Element Analysis:
   - Mechanical design criteria - Function, strength and cost. Introduction to FEM Software – meshing, mesh refinement, apply loads and constrains, assign material properties A machine component design exercise - use FEA software to determine dimensions and materials for all parts, modify, optimize and verify the design
   - Numerical result analysis and assessment - von Misses stress, displacement.


Section II

5. Computer aided Designing:
   - Design of components and systems for stress analysis and heat transfer using fully Featured commercial finite element software having linear & non-linear capabilities. (To be assessed through various course works). Verification of results for the component Analyzed with appropriate hand calculation
   1. Eigen values and Eigen vector computations for level control applications
   2. Applications of vectors to problems in fluid mechanics, continuity equation, stream lines equations of motion. Bernoulli’s equations
   3. Numerical interpolation
   4. Numerical integration
   5. Integration of ODE – Equation for batch Reactions
   6. Numerical differentiation
   7. Root-finding method-two non linear equations
   8. Linear programming for solving liquid level in tank model.
   9. Data fitting
   10. Process calculation using MS-Excel
   11. Application of neural networks
   12. Fuzzy logic application
   13. Application of support vector machines
   14. Design algorithms
   15. Non-linear optimization methods-Interacting and Non Interacting System
   16. Regression Analysis

6. Computational Fluid Dynamics:
   - Form of mass, energy and momentum equations, description of terms; boundary Conditions and simple solution examples. Features of CFD Modeling for steady Incompressible flow, pressure drop and heat transfer. Solution Methods - Solution Algorithms, discrimination schemes, solution convergence, and residuals. Model
Formulation - Geometry and grid design, boundary conditions of the domain, choice of Physical models for turbulence and heat transfer, modeling of fluid properties. Case Study Examples - Modeling pressure drop and heat transfer in a range of engineering

Reference Book-
1. CAD/CAM Theory & Practice Zeid TMH.
4. Introduction to FEM. KJ. Bathe CPC. Press.

(WT 4.42) Advance Brewing Technology

Section I
1. 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.
2. 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
4. Inoculums Preparation & Strain Improvement- Primary Screening, Secondary Screening, Mutation, Natural mutations Artificial induction of mutation, selection of high Producers, Revert mutants. Genetic Engineering of yeast.

Section II
5. Filling 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. Bottles, plastic screw cap closures, Can filling, low oxygen closure, closure procedure,
Filling of wooden barrels & Casks


9. Industrial Licensing

Reference Book -
2. Technology Of Brewing & Malting- Wolfgang, Kunze
6. Industrial Microbiology- Prescott SC. & Dunn CG. Jodhpur Agro bios India 2002 81-7754-149-8
11. Govt. of India Technical Excise Manual (663-16Gov.)

(WT 4.43) Advance Enology

Section I

1. Principal Constituents of Grapes-Sugar, Acid, Mineral Salts, Polyphones, Tanins, Anthocyanins, Flavor Components, Proteins Colloids, Version & Maturity
4. Fermentation- Cultured yeast, Control of temp, Monitoring, Stopping the Fermentation & A stuck Fermentation Naturally sweet wines. Malolactic fermentation, Cool fermentation, Skin contact, sur lie Battonage, Prevention of Oxidation, fermentation in barrel Tumultuous fermentation. Maturation in wood

Section II

1. Principal Components of WINE- Alcohol, Acids Volatile Acidity Residual sugar, Glycerol, Aldhydes & Ketones
2. Clarification & Stabilization – Racking, Protection from Oxidation, Blending, Fining- Fining agent, Blue Fining, Calcium Phytate, Tartarate Stabilization, Cold stabilization Contact process, Electro dialysis
4. Additives- So2, Antioxidants, Antiseptic, Antioxidasic, Free & total So2, Molecular So2, Ascorbic Acid, Sorbic Acid Meta Tartaric Acid, Citric acid, Copper Sulphate, Acacia gum, (gum Arabic) Enzymes- Pectinolytic, Betaglucanases, Lysozyme
6. Wine Faults- Beyond Shelf life, Oxidation, Tartarate crystals

Reference Book-
1. The Production of Grapes & Wine in cool Climates. David Jackson & Danny Schuster
4. Understanding Wine Technology-David Bird
5. Practical aspects of Wine Filtration-Bernard Gautier.
10. American Society for Enology & Viticulture-Seattle
13. Understanding Wine Course Notes Patric II & Peter Gago
14. Wine Science- Ron S. Jackson
17. Wine Making From Grape growing to Market Place Richard P. Vine, Eilen Harkness. Salley J. Linton
19. Wine Appreciation-Richard P. Vine
(WT 4.44) Second Generation Biofuels

Section I

1. Production of Fermentation Alcohol as a fuel Source-A Historical account
   Enzyme hydrolysis of Starch & Cellulose
   Industrial Production of alcohol by continuous Fermentation, Kinetics of alcohol fermentation, at High yeast level, kinetics of Product inhibition & substrate inhibition Effect of Ethanol On kinetics of Continuous Fermentation, Commercial Fermentation of Cheese Whey for the production of Ethanol. Ethanol production in an immobilized cell reactor

Section II

6. Productions of alcohols other than Ethanol for fuel Purpose like Butanol,High Grade fuels from Biomass Farming, Bioenergy from Waste,Biogas Production from Food Processing Industries, Hydrogen gas Production Energy Cropping, Petroleum Plants, Jatropha curcas (Mogali Erand) Pongamia pinnata (Karanj,) Distillation of Fuel alcohols

Reference Book -

1. Industrial Microbiology- Prescott & Dunn.
3. Biotechnology-B.D.Singh
5. Alcoholometry-Satyanarayana Rao
(WT. 4.45) Project Work (Which will be of Individual/groups /in plant training)

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 the Processes involved in Wine technology, Brewing technology or Alcohol technology.

Student has to undertake an extended rise arch 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. Student 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.