

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 & McCabe 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.
4. Multiple effect evaporations of pot ale, theory & industrial examples. Mechanical & thermal compression. Pot still shape & design & its effect on spirit quality purifiers.

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-

1. *The Alcohol Text Book*-Jacques T. P. Lyons & D.R. Kelsall
2. *Alcoholometry*-Satyanarayana Rao
3. *Hand Book of Fermentation & Distillation* –A.C. Chatterjee
4. *Distillation* H.C. Barron.
5. *By Products Of Sugar Industry*- Paturao
6. *Whisky Technology, Production & Marketing* -Inge Russell

(WT 3.2) Brewing Technology II

Section I

1. The Brewing Process from mash mashing to fermentation vessel/wash back effect of boiling on wort composition. Fermentation difference between brewery & distillery wort, osmotic effects, yeast sensing system. Beer & Spirits processes
2. Alcohol drinks definition & legislation, alcohol & health. Product quality, Industrial Licensing – recent rules up to 2013
Quality Control & techniques, quality assurance, Online laboratory analysis & Measurement. Flavour assessment technique.
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.
5. Flow of Fluids in Pipes and through Pumps in a Brewery Setting. Heat transfer through flat and curved surfaces and effects of insulation and fouling on efficiency. Theory and Practice of Carbonation including mixed gas technology. Theory and Practice of Refrigeration in the brewery

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.
3. Raw material specifications, quantities & processing parameters, Product specifications & product formulation, Preparation and analysis of raw materials intermediates & final products.
4. Designing flavor evaluation test, Carrying flavor evaluation, Analyzing results & evaluation. Report writing of final product.
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*
4. *Brewing Engineering: Quantification and Calculation.*
5. *American Society of Brewing Chemists USA-Method of analysis of American Society Of brewing chemists (8th rev.) USA American Society of brewing chemists 1996 1-88 ,1696-01-4 (AME)*
6. *Brewing- Michael Lewis & Tom young Edition II- Kluwer Academic/ Plenum Publishers New York.*
7. *Technology of Brewing & Malting –Walfgang kunze III-VLB Berlin.*
8. *Alcoholic beverages- Birch G.G. Elsevier Applied Science Pub 1985 (663.1 BIR)*
9. *Industrial Microbiology. Prescott S.C. & Dunning Jodhpur Agro bios (India) 2002. 81-7754-149-8*
10. *Brewing Science Vol. 1 Pollock JRA & ed. Academic Press 1979. (663.3 POL)*
11. *Brewing Science Vol.2- Pollock Jra & ed, Academic Press 1979 (663.3 POL)*
12. *Malting & Brewing Science- Vol-2 Hough T.S. Briggs D.E. Steven R. Young T.W. Chapman & Hale 1982-(663.3 H0u.)*
13. *Brewing Microbiology -2nd Ed 1996 UK Priest FG Chapman & Hall 1996 0412591502(576 PRI)*
14. *Hand Book of Brewing -Hard Wick WA-ed New York Marcel Dekker Inc 1995 (663.3 HAR HAR)*
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 mount ,Ice wine, curio extraction, passion & renato style
3. Rose Wine- Drawing off, Direct pressing, Tavel Rose, Bearn Rose, Difference between Red & Rose, Blush Wine, Mateus, Quality Criteria for Rose wine & Grape Varieties.
4. Bottles & New Trends in Containers- Glass Bottles Making, Advantages &

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 Zeland, 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 shampanoski , 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-

1. *Hand Book of Enology Vol.1 The Microbiology of Wine & Vinification.*
P. Ribereau- Gayon .D. Dulubourdieu, B. Doneche A Lonaud.
2. *American Society for Enology & Viticulture –Seattle*
3. *Australian Society of Viticulture & Enology- Andrew Markides, Richard Gibson.*
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*
7. *Hand Book of Enology Vol.2 The Chemistry of Wine Stabilization & 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 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.*
11. *Wine appreciation-Richard P. Vine.*

(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
2. Heat transfer- Conduction, Convection, Thermal resistance & Heat flux, Types of heat exchangers, Nucleate boiling curves Calculation of boiling heat flux. Vapor compression, Heat efficiency. Heat transfer through flat & curved surface & effects of insulation & its efficiency.
3. Thermodynamics- Gases & their properties, Vapor pressure, Gibbs phase rule, Ideal gas law, Equation of state compressibility factor, Energy balances specific & latent heat, Enthalpy, Entropy, Internal energy Heat & work, Open & Closed systems. Thermodynamic diagrams, power & refrigeration.

Section II

1. Fluid Mechanics- fluid static, fluid dynamics, flow measurement, pipe/duct flow. Frictional pressure losses in pipe/duct, flow pumps /fans, cavitations, net pressure, suction head. Flow of Fluid in Pipes & through Pump in brewery Setting.
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*
4. *Unit Operations of Chemical Engineering 7th Editional Warren L. McCabe, Julian C. Smith, Peter Harriott Mc Graw Hill*
5. *Chemical Engineering Vol.3 (Chemical & Biochemical Reactors & Process Control) Third Edition. J.F. Richardson & D.G.Peacock-Asian Books Pvt Ltd.*

(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
21. Studies on spirit Processes - Denatured Spirit, absolute Spirit , Neutral Spirit etc

Semester –IV

(WT 4.1) Business Management

Section I

1. Operations Management :
Operations: explores the concept of operations and operations management 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*
2. *Fundamentals of Marketing- Anonymous- Stallion International Student edition*
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*
7. *Business Organization & Management Shekla & Saxena.*

8. *Fundamentals of Marketing-Willam J. Stanton, Michal J. Etrell, & Bruce J. Walker*
9. *Marketing Management-J. C. Gandhi*
10. *Operations Research-Satish Jawale*
11. *Office Organization & Management S. P. Arora*
12. *Essentials of Management-An international Perspective-Herald Koortz-Hein Wehrich*
13. *Business Management- Dr. P.C. Pardeshi*
14. *Export Marketing of Indian New Manufacturers Khanna S. R. 1985-University of Delhi*
15. *Business Policy Azar Kazmi I. 1997 Tata Mc Graw Hill Publishing Co. Ltd. New Delhi*
16. *International Marketing Management 1999 Sultan Chand & Sons (An Indian Perspective) R. L. Varshneya & B. Bhattacharya. New Delhi-110002*
17. *Hand Book of Metrics for Research in Operations Management-Aleda V. Roth Roger, G.Schroeder & Xiaowen Huang, M Mrat Kristal.*
18. *Key Concepts in Operations Management- Michael Lesure.*
19. *Operations Management-Prof. Nigel Slack, Dr. Stuart Chambers, Robert Johnston.*
20. *Customising Material Management With SAP/ERP Operations-Akash Agrawal*
21. *Operations Management-J. Ross*
22. *Seven Steps to Mastering Business analysis. Barbarra A. Calehord*

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 topic 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 III ustrated 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, Insitu 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*
3. *Principles of Fermentation technology P.F. Stanbury . A.Whittaker & J.J. Hall*
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*
8. *Methods of Analysis of Soil, Plant, Water Fertilisers & Organic Manures.*

(WT 4.3) Alcohol Technology III

1. Yeast & Fermentation – Essential Properties of distilling yeast, Yeast Biochemistry & Structure. Carbohydrate, Nitrogen & Oxygen Metabolism, Cultivation of distillery. Yeast. Rotary Vacuum Drying for Filtration of Distillery Yeast. Design of Fermentation Vessels, Kinetics’ of yeast growth. Production of Co₂, Contamination, – Possible contaminants & their Control, Cleaning disinfection & Sterilization requirements in distilleries.
2. Batch distillation Principles & Procedure- Design of distillery, Wash still Operations,, Spirit still operations, Product Quality, Calculation of distillery Yield. Triple distillation, Dealing with distillery problems. Simple distillation, Grain Whisky distillation,- Continuous distillation, Coffey still, 8 Design & Operation of Continuous grain Whisky Stills ,Thermo compressor for steam recovery, Aeration Removal of Fients ,Development of Flavor. Craft of Whisky Distillation- Preface,
3. Maturation, Cooperage Oak wood, Structure of wood Casks Manufacture, Timber Processing, Barrel ageing. Heat treatment Chemistry, Sherry cask construction, Cask regeneration. Scotch Whisky Maturation, Maturation reaction, Additive & Substrative activity, Evaporation, Adsorption & degradation by char, Chemical degradation , Masking Maturation in ex-sherry Casks, Maturation in ex-bourbon Casks ,Maturation in regenerated casks Maturation time Bottling.

Section-II

4. Blending – Definition, Why blend ? What does blending involve ? The Flavor Specialist ,Role of grain Whiskeys in the blend, Ratio Of grain to Malt Whiskey, Strategy, Practicalities of Blending.

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 congeners, Maturation Congeners Whisky age, PH, Residue, Ash Anions & Cations ,Volatile Phenolic congeners & 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

6. Indigenous Spirits of World- Sake, Toddy, Arak, Schozu, Hodia, Saufia, Cashew fenny, Absinth, Rum Vodka, Gin, Cordials & Liquears, Asian Liguor Schnapps, Aqa-vit, Tequila Anise, Vermouth, bisco, Apple Cider Kefir, Cachaka, Cocktails.

Reference Book-

1. *The Alcohol Text Book- Jacques T. P. Lyons & Dr. Kelsall.*
2. *Alcoholometry- Satyanarayana Rao*
3. *Hand Book of Fermentation & Distillation- A. C. Chatterjee*
4. *Distillation- H.c. Barron.*
5. *By Products of Suger Industry- Paturao*
6. *Whiskey Technology, Production & Marketing- Inge Russel*
7. *Malt Whisky- Chales Mc Lean*
8. *Technology Brewing & Mallting- Wolfgang Kunze 4th International edition.*

(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.

4. Product Design- Definition, Importance, Factors affecting Products, Design Product Policy, Standardization, Simplification Production Development Meaning, Importance, Factors Responsible for development. Techniques of Product Development

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.*
2. *Finite Element Method-Bela gunda & Chandru pata New age Int. Publ.*
3. *Introduction to FEM. Reddy J. N. M.c Graw Hill Inst.*
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, Fluometric Vitality test, Saccharomyces wild yeast, Non Saccharomyces Wild yeasts, Biofilms, Controlling contamination
3. Fermentation Management- Wort collection, wort cooling & Clarification, Wort Oxygenation, Control of yeast Pitching rate, Direct Weight of yeast cake, Addition of yeast Slurry Cone- Cone Pitching, use of infrared turbidometry Monitoring, Fermentation Progress, Wort gravity Co2 evolution, PH, rate of O2 assimilation yeast, growth, Ethanol formation Vicinal dike tone Concentration, Effects of process Variables on fermentation Performance, Factors influencing abnormal fermentation.
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
6. Small Scale Brewing – Micro Brewers, Hobby brewers, making your own malt. Pub breweries, brewing plant. plant & Process diagram of pub breweries. Fermentation & Maturation cellar, Dispense equipment ,Types of Beer. Energy Supplies, Legal Regulations.
 7. Energy Management in the brewery & Malting- Energy Requirements in Malting & brewing- Boiler plant types of boiler- Fuels, Steam-Heat of evaporation, Wet steam, Super heated Stream. Hot water, Energy recovery & improvement of Efficiency, Return of Condensate , Refrigeration plant, Refrigerants, Cooling agents, Operating principle of refrigeration, Compressors, Evaporators, condensers, Control valves, Ice water storage. Absorption cooling machines- cooling of Conventional Fermentation & Lager cellars, Stationary cooling, Air circulation cooling, Modern cooling plants, cooling of liquids. Single stage cooling, Double stage cooling.
 8. Cereal harvesting & storage, Physiology & Biochemical Composition of cereals, Biochemistry of GA3/ aleuronic response in cereals, Structure & Chemistry of cereal grains used for adjunct Production. Cereal adjunct in Brewing & Distilling, Cereals used in Malt Production. Unmated cereals, other brewing extracts & Quality Control Procedure. Physiology of cereal germination.
 9. Industrial Licensing

Reference Book -

1. *Beer Quality, Safety & nutritional aspects.* P. S. Hughes & E. D. Baxer
2. *Technology Of Brewing & Malting-* Wolf gang, Kunze
3. *Alcoholic beverages-* Birch G.G. Elsevier Applied Science Publication 1985 (663.1 BIR)
4. *Brewing-* Michael Lewis & Tom Young
Edition II Kluwer Academic Plenum Publishers New York.
5. *American Society of Brewing Chemist USA- Methods of analysis of American Society of brewing Chemist 1996-1-88-1996-01-4 (AME)*
6. *Industrial Microbiology-* Prescott SC. & Dunn CG. Jodhpur Agro bios India 2002 81-7754-149-8
7. *Brewing Science-Vol.1 –Pollock JRA & ed Academic Press 1979(663.3 POL)*
8. *Brewing Science-Vol-2-Pollock JRA & ed Academic Press 1979(663.3 POL)*
9. *Brewing Microbiology 2nd ed 1996 UK Priest FG Chapman & Hall 1996 041291502 (576 PRI)*
10. *Hand Book of Brewing-* Hardwick W.A. ed. NewYork Marcel Dekker, Inc-1995 (663-3 HAR HAR)

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, Polyphenols, Tanins, Anthocyanins, Flavor Components, Proteins Colloids, Vignification & Maturity
2. Role of Oxygen, Anaerobic Wine Making, Antioxidants, Inert gases Carbon Dioxide, Nitrogen, Argon, Noble Gases - Helium, Neon, Krypton & Xenon, Dissolved Oxygen, Sparging, Hyper oxidation Micro Oxygenation, Theory & Practice of Carbonation including mix gas technology.
3. Must Production- Machine harvesting, Destalking, Crushing, Draining juice, Pressing Skin- The basket press, Horizontal screw Press Pneumatic Press, Tank press, Continuous Screw Press, Adjusting Musts- SO₂, Clarification, Settling Centrifuging, Flotation, Acidification, De- Acidification, Enrichment of Grape must. Must Conc. Vacuum distillation, Cryo-extraction. Reverse osmosis. Nutrients & other treatment
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, Aldehydes & Ketones
2. Clarification & Stabilization – Racking, Protection from Oxidation. Blending, Fining- Fining agent, Blue Fining, Calcium Phytate, Tartarate Stabilization, Cold stabilization Contact process, Electro dialysis
3. Filtration- Limpidity, History, Principles of filtration Porosity, permeability, Filtration Equation, Nature of Clouding, Preparation for filtration of wines from rot affected Grapes, Beta Glucanase detection in wine, Modern enzymatic Preparation for better filtration, Wines Presenting risk in filtration Average Conditions of use of enzymes, filtration units- Vertical Bell filtration, Rotary Drum, Press filtration with hollow frames, Horizontal bell filtration Sheet filtration, membrane filtration, Cross flow filtration (Tangential filtration) Ultra filtration.
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, β-glucanases, Lysozyme

5. Quality Control & Analysis- Quality plan, Technical Specifications for wine- density, Alcoholic Strength, Total dry extract, Total Acidity PH, Volatile Acidity, Residual Sugar Tartarate Stability & Protein Stability test, Free So2 & total So2 Contaminants-Dissolved O2, Iron & Copper, Sodium Microbiological analysis, Quality assurance, Hazard analysis & Critical Control Point (HACCP)
6. Wine Faults- Beyond Shelf life, Oxidation, Tartarate crystals Foreign bodies, Musty taint, Volatile acidity, Secondary Fermentation Iron casse. Copper Case. Mousiness, Geranium Smell.

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, Elien 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 4.44) Second Generation Biofuels

Section I

1. Production of Fermentation Alcohol as a fuel Source-A Historical account
2. Raw Materials for Ethanol Fermentations, Sugar Containing raw materials, Starchy raw Material, Cellulosic raw materials
Enzyme hydrolysis of Starch & Cellulose
3. Rapid Ethanol Fermentation, Batch vs. continuous System, A vacuform Process. 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

4. Mandioca & Sugarcane Fuel alcohol, Gasohol, Gasohol-Energy Mountain or Molehill ? Alcohol- Gasoline blends- Exhaust emissions, Fuel Economy & driveability of Vehicles, Alcohols- A technical assement of their application as fuels. Technical Feasibility of Diesohol & Gasohol
5. Energy & Ethanol, Gasohol Ethanol & energy ,Net Energy ,analysis of Ethanol Production, Alternative's for energy savings at plant level for Production of alcohol for use as automotive fuel.
6. Productions of alcohols other than Ethanol for fuel Purpose like Butanol,High Grade fuels from Biomass Farming, Bioenergy from Waste ,Biomethanisation, Biogas Production from Food Processing Industries, Hydrogen gas Production Energy Cropping, Petroleum Plants, Jatropha curcas (Mogali Erand) Pongamia pinnata.(Karanj,) Distillation of Fuel alcohols

Refernce Book -

1. *Industrial Microbiology- Prescott & Dunn.*
2. *Technology, Brewing & Malting- Wolf gang, Kunze. 4th International edition.*
3. *Biotechnology-B.D.Singh*
4. *Whisky Technology Production & Marketing- Inge. Russel.*
5. *Alcoholometry-Satyanarayana Rao*
6. *Hand Book of Fermentation & Distillation –A.C.Chatterge.*

(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 research 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 analyse 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.