

**University of Pune**  
**Syllabus for**  
**M. Sc. Wine Technology**  
**(Wine, Brewing and Distilling)**

**Course Structure 2010-11**

**Eligibility: Graduate in Botany/Zoology, Biotechnology, Microbiology Chemistry, Wine Technology and B.E./B.Tech. in Engineering having 50% marks for Open and 45% marks for Reservation category)**

1. There will be FIVE courses in each semester.
2. Each course will be of 100 marks and 48 lectures.
3. Practical course will be of 24 practical having each practical is of 4 hours.

**M. Sc. Part – I**  
**Semester-I**

WT 1.1 Viticulture  
WT 1.2 Microbiology of Alcohol, Beer and Wine  
WT 1.3 Biochemistry of Alcohol, Beer and Wine  
WT 1.4 Practical-I  
WT 1.5 Practical- II

**Semester-II**

WT 2.1 Alcohol Technology-I  
WT 2.2 Brewing Technology-I  
WT 2.3 Enology-I  
WT 2.4 Chemical and Plant Engineering-I  
WT 2.5 Practical- I

**At the end of second year students can take Summer Training Program as a part of Project which will carry 20 marks and also initiate the work on a project topic assigned and can be completed during forth Semester. Project will carry 80 marks and will be examined at the end of second year along with other courses.**

**Semester-III**

WT 3.1 Alcohol Technology –III  
WT 3.2 Brewing Technology-II  
WT 3.3 Enology-II  
WT 3.4 Chemical and Plant Engineering-II  
WT 3.5 Practical- I

## **Semester-IV**

WT 4.1 Business Management

WT 4.2 Industrial waste treatment & Environmental management

WT 4.3 Alcohol Technology-III

**Any one of the Optional courses WT 4.41 to 4.44 from the Following:**

WT 4.41 CHEM-CAD design (CCD)

WT 4.42 Advance Brewing Technology

WT 4.43 Advance Enology

WT 4.44 Second Generation Biofuels

WT 4.3 Project work (Which will be of individuals/groups/Inplant training)

## **M. Sc. - I Semester-I**

### **WT 1.1 Viticulture**

#### **Section-I**

1. The origin, taxonomy and Biogeography of the grapevine- Prehistoric evidence for Vitis, differences between muscadine grapes & Evatis species; The grape and maturation processes
2. Vegetative and reproductive structures of vines and their developments
3. The grapevine and its varieties including Indian varieties  
Varieties of grapes: white wine grape Red wine grape varieties.
4. Soils and Climate: Soil formation, soil classification. Types of soils required for grapevine cultivation. Major and minor soil elements. Climatic conditions : temperature, rainfall, humidity, wind and light for grapevine cultivation.
5. Vine cultivation: Pruning the vines; Methods of cultivation. Vine Pests & Diseases: Vine diseases; Vineyard pests; Phylloxera; Bacterial diseases of the Grapevine- Pierce's disease, Crown Gall;

#### **Section-II**

6. Viral diseases of the Grapevine- Fan leaf degeneration; Grapevine Leaf roll; Fungal diseases of the Grapevine- Downy Mildew, Powdery Mildew, Black rot, Dead-arm, Anthrac nose, Pierce's diseases, Crown Gall. Integrated Pest management.
7. The site selection and its characteristics required for grapevine cultivation and rootstock selection..
8. Methods of grapevine propagation.
9. Preparing the grapes, assessment of maturity and harvesting  
Specific gravity & potential alcohol: Pressing.

## Reference Books:

1. *American Society for Enology and Viticulture- Seattle.*
2. *Diseases and pests- Phil Nicholas, Peter Magarey, Malcom Wachtel.*
3. *Viticulture Vol.I- Resources- P. R. Dry, B. G. Coombe.*
4. *Viticulture Vol. II- Practical- P. R. Dry, B. G. Coombe.*
5. *Pesticide Applications in Vineyards- John Kent, Richard Early.*
6. *Soils for fine wines- Robert E. White.*
7. *Australian Society of Viticulture and Enology - Andrew markides, Richard Gibson.*
8. *Grape pest management- Donald L. Flaherty, L. Peter Christensen, W. Thomas Lalini, James J. Marosis, Phil A. Philips, Lloyd T. Wilson.*
9. *Introduction to wine making – Viticulture and Enology 3- Prof. Ralph E. Kunkee.*

## WT 1.2 Microbiology of Alcohol, Beer and Wine

### Section-I

1. Importance of microorganisms, occurrence, types of microorganisms.
2. Stain and staining procedures – Definition of stain and dyes, types of stain; procedure and mechanism of Gram staining, Acid fast staining. Negative staining.
3. Classification of microorganisms,  
Difference between prokaryotic and eukaryotic cells, types of bacteria, fungi, viruses, protozoa and algae.
4. Cell – Biology – Detailed study of bacterial cell organelles, cell wall, cell membrane, capsule, endospore, flagella, types of flagella, mechanism of flagellar movement.
5. Sterilization & Disinfections: Definition of sterilization & disinfections; physical and chemical agents application for sterilization . Desiccation, Osmotic pressure, Radiation, U V light, X-ray, gamma rays & cathode rays, filtration (Bacteriological filter, Air filters), HEPA filters, face masks, ultrasonic & washing.  
Isolation, enumeration and identification of yeasts, various bacteria significant in alcohol and wine production.

### Section-II

6. Growth: Definition of growth, growth kinetics, factor affecting the growth curve, measurement of growth, continuous culture, chemostat, turbidostat, dialysis technique, synchronous growth.
7. Nutrition: Autotrophic, heterotrophic & photosynthetic organisms, uptake of nutrients.
8. Pure culture techniques- enrichment culture technique, design & preparation of media – Nutritional requirements ingredients of media, types of media. Preservation of pure culture techniques, slant culture preservation, Lyophilization.
10. Yeast – Definition, comparison with other microorganisms, yeast morphology and taxonomy, yeast cell structure and functions of various cellular components. Nutritional requirements of yeast, Aerobic and anaerobic metabolic pathways in

yeast for sugar dissimilation, Isolation and Maintenance of yeast, Stoichiometry of alcohol production.

#### 11. Role of soil micro-flora in vineyards and sugar canes fields

#### Reference Books:

1. *The microbial world – Stainer*
2. *General Microbiology – Volume I and II Power and Dagainwala*
3. *Elements of Microbiology – Pelczar*
4. *Principles of Microbiology – Sanyogita Wadikar*
5. *Microbial Technology – Papler Vol. I and II*
6. *Industrial Microbiology – Casida*
7. *Wine Microbiology and Biotechnology- Graham H. Fleet.*
1. *Prescott, S.C. & Dunn, C.G.: Industrial microbiology. Jodhpur. Agrobios (India), 2002. 81-7754-149-8*

#### WT 1.3 Biochemistry of Alcohol, Beer and Wine

##### Section-I

1. Introduction to living cells, classification of living cells, structure and function of cells. DNA/RNA and protein synthesis.
2. Photosynthesis: Definition, importance and mechanism, light reaction, Dark reactions and factors affecting the photosynthesis rate.
3. Proteins: Characteristics and classification of proteins, protein structures primary, secondary, tertiary and quaternary and proteins in sugarcane juice.
4. Amino Acids: Classification and properties of amino acids in sugarcane juice and molasses. Reactions of amino acids. Peptide bonds .  
Amino acid metabolism, lipid metabolism, mineral metabolism
5. Carbohydrate metabolism, Glycolysis, TCA cycle, Pentose Phosphate pathway, Glyoxylate cycle, Metabolism of amino acids.
6. Enzymes: definition, classification, co-enzymes, co-factors, enzyme kinetics, factors affecting enzyme reactions, regulation of enzyme activity. Industrial application of enzymes.

##### Section-II

7. Metabolism of sugars & organic acids by Lactic acid bacteria from wine & must.
8. Vitamins: classification, biochemical and physiological functions
9. Transport of sugars & sugar alcohols by Lactic acid bacteria.
10. Amino acid metabolism & production of biogenic amines & ethyl carbamate.
11. Usage & formation of sulphur compound.
12. Microbial formation & modification of flavor & off-flavor compounds in wine.  
Exoenzymes of wine microorganisms.
13. Biochemistry of brewing
14. Recombinant DNA Technology

### Reference Books:

1. *Biochemistry –Lehninger*
2. *Biochemistry – West and Todd*
3. *Wine Microbiology and Biotechnology- Graham H. Fleet.*
4. *Concepts on wine chemistry- the wine appreciation guide- Yair Margalit, James Crum.*
5. *Chemical analysis of grapes and wine techniques and concepts- Patrick ILAND, Nick BRUER, Andrew EWART, Andrew MARKIDES, John SITTERS.*

### WT 1.4 Practical-I

1. Morphological and anatomical studies of grapevines and sugar canes varieties and to note differences —3P
2. Field practicals on cultivation practices of grapevine and sugar canes such as pruning, grafting, spacing etc ----2P
3. Illustrated field exercises for harvesting and handling of grapevines –1P
4. Soil analysis : pH, temperature, soil texture, porosity, NPK, organic carbon, salinity, EC, soil moisture. (4P)
5. To collect infected samples and study the morphology of major pest and their life cycle 4P
6. Water Analysis: pH, alkalinity, hardness, chlorites EC, nutrients (3P)
7. Determination of Brix, Specific Gravity, pH of molasses
8. Determination of moisture and ash content of molasses.
9. Determination of total solids and suspended solids of molasses.
10. To determine the reducing sugar in the given sample of final molasses.
11. To determine the total reducing sugar in the given sample of final molasses.
12. Estimation of calcium content of molasses by EDTA method.
13. Estimation of calcium content of molasses by Ammonium oxalate method.
14. Determination of sludge content of molasses.

### WT 1.5 practical-II

1. Preparation of culture media & sterilization.
2. Preparation of MGYP medium for growth & Identification of yeast.
3. Preparation of MGYP & molasses medium slants.
4. Enumeration of microorganisms by four-quadrant method.
5. Enumeration of microorganisms by using spread plate technique.
6. Counting of microorganisms by pour plate method.
7. Preparation of slide culture of yeast.
8. Negative staining and monochrome staining and Gram staining.
9. Determination of nitrogen content by Kjeldahl's method.
10. Estimation of sugars by Arseno-molybdate method.
11. Determination of alcohol content by spectroscopic method.
12. Estimation of enzyme activities such as amalyse, glucoamylase (3P)
13. Estimation of proteins byBiuret and Lawry method (2P)

14. Determination of ethyl alcohol content of spirit by specific gravity method.
15. To determine the total sugars as invert sugars in final molasses.
16. Determination of total organic volatile acids of molasses.
17. Determination of total organic volatile acids of fermentation broth sample.

## **Semester –II**

### **WT 2.1 Alcohol Technology – I**

#### Section-I

1. Stimulation and Acclimatization of yeast in distillery; Design of yeast vessels, material of construction and its maintenance. Propagation practices of yeast adopted under plant conditions. Measurement of number of yeast cells/yeast count etc. Use of Bakers yeast. Active Dry yeast and yeast Acidification / pretreatment practices. Pre-fermentation practices adopted for yeast propagation prior to inoculation to main fermenter. Prefermenter (Blue) design, material of construction and its maintenance. Use of sterile air/sparging system in Prefermenter.
2. Raw material for yeast fermentation, molasses composition, grades, storage and cost. Details of molasses weighing system.
3. Molasses dilution practices adopted and design of diluter, quality of dilution water used, pre clarification of molasses advantages and draw back, molasses sterilization/pasteurization.

#### Section-II

4. Process of Batch fermentation, factor influencing efficiency of fermentation, characteristics of Batch Fermentation Process, Control over fermentation operation, contamination control, design and material of construction of fermenters, maintenance of fermenter and operational conditions on plant scale, flow sheet of Batch Fermentation process, Efficiency of Fermentation and Attenuation data calculations – Related examples and solutions.
5. Role of excise in distillery unit, Excise rules and regulations.
6. Quality of water and molasses dilution practices.
7. Alcoholmetry – proof spirit (British and USA proofs) over proof, under proof, specific gravity of alcohol strength of alcohol in terms of concentration – related examples and solution.
8. Prevention of losses of alcohol during fermentation, post – fermentation practices/scrubbing etc.

### **Reference Books:**

1. *The Alcohol Textbook – Jacques, T. P. Lyons & D. R. Kelsall*
2. *Alcoholometry – Satyanarayana Rao*
3. *Handbook of Fermentation and Distillation – A.C. Chatterjee*

4. *Distillation – H. C. Barron*
5. *Technical Excise Manual*
6. *Byproducts of Sugar Industry – Paturao*

## **WT 2.2 Brewing Technology-I**

### **Section-I**

1. History of Industrial Brewing: Introduction, Brewing in an Agrarian World, The Eighteenth century: Porter: The First Industrial Beer. Mechanization & Measurement, The Nineteenth Century: Porter Vs Ale, the rush to bottom fermentation, science & practice. The Twentieth Century: Beer and Society, Temperature and prohibition. Consumer choice Fewer & Bigger: The path to Globalization, Science Applied & Technology Transformed.
2. Beer Styles: Their origins and classification-Introduction: How different styles are created, Factors involved in styles of Beer, Ingredients: Water, fermentable carbohydrates, Hops yeast, Processing: Equipment configuration, milling, mashing Lautering, Boiling time, Fermentation Temperature, Maturation time, filtration, Packaging, Marketing, Cultural Origins of style, Analytical and Sensor variables, Beer style guidelines, analysis, tasting &, Brewing Beer. The Beer Styles-Ales British Origin, Irish Original, German Origin, Belgian and French Origin, Lager Beer, European- Germanic origin, North American Origin, Other Origin.
3. An overview of Brewing: Introduction, outline of the Brewing steps, Malting, Milling and Adjunct Use, Mashing, Wort separation, Wort boiling, Trub removal, Wort cooling/Aeration, Yeast handling, Yeast pitching, Fermentation, Yeast removal, Aging, Clarification, packaging warehousing and distillation.
4. Water: Water usage in the Brewery, Brewery water consumption, Brwery water Calgary's: Brewing water, water standards: chemical and microbial for ingredient use and influence of inorganic ions from water on Beer Quality, ingredient effect of ions on Beer flavor and quality, control of pH, water treatment systems.

### **Section-II**

5. Barley and Malt: - Barley – Structure and function, the husk the pericarp, testa, Aleurone Layer, Starchy Endosperm, The Embryo, Malt Production, Drying, Storage, and Handling, steeping, Germination, Kilning and Malt Quality, Malt varieties.
6. Adjuncts: Introduction, Corn Grits, Rice, Barley, Sorghum, Refined Corn Starch, wheat starch, cereals, liquid adjuncts, Malt from cereals other than Barley. Wheat Malt, Oats and Rye Malt, Sorghum.
7. Hops: Hop Growing, History, the hop plant, Hop classification, Hop cultivation, Harvesting, drying and packing, Hop varieties, Hop chemistry, whole Hops, Hop Resins, Soft Resins, Hard Resins, Hop oils, Hop storage, Hop variety, Hop oils, Hop resin acids, Bittering value, Bitter flavor and foam – Role of  $\alpha$ -acids, Reduced Iso  $\alpha$ -acids, The "Light struck" Reaction, Inhibition by reduction, Manufacture of reduced Iso- $\alpha$ -acids Hop products, Development of Hop products, Benefits of Hop products.

## Reference Book:

2. *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)*
3. *Arntzen, C.J., ed.: Encyclopedia of agricultural science, vol. 1: - A - D. N. York, Academic Press, 1994. Rs.18802.00-- (630.3 ARNARN)*
4. *Birch, G.G.: Alcoholic beverages. London, Elsevier Applied Science Pub. 1985., Rs.369.20-- (663.1BIR)*
5. *Government of India. Technical Excise Manual. --(663.16GOV)*
6. *Hardwick, W.A., ed.: Handbook of brewing. N.York, Marcel Dekker, Inc., 1995., Rs.6181.50--(663.3 HARHAR)*
7. *Hough, J.S., Briggs, D.E., Stevens, R., Young, T.W.: Malting & brewing science, vol. 2 : hopped wort & water. London, Chapman & Hall, 1982. Rs.591.50- (663.3HOU)*
8. *Pollock, J.R.A., and ed.: Brewing science vol. 1. London, Academic Press, 1979, Rs.7046.80-- (663.3POL)*
9. *Pollock, J.R.A., and ed.: Brewing science, vol. 2. London, Academic Press, 1981., Rs.7046.80-- (663.3POL)*
10. *Prescott, S.C. & Dunn, C.G.: Industrial microbiology. Jodhpur. Agrobios (India), 2002. 81-7754-149-8*
11. *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*

## WT 2.3 Enology-I.

### Section-I

1. Introduction: History of wine making, present international and national status of wine production and wine market, scope and importance of wine industries, nutritional and therapeutic value of wine, commercial aspect of wine production.
2. Classification of wine- table wines, sparkling wine, dessert wines, aperitif wine, pop wine.
3. Wine making processes- Red wine production-time of harvest, harvesting, crushing & fermentation, blending; White wine production- White wine styles, harvesting, crushing, pressing, settling/clarification & fermentation.
4. Sparking wine- The Champagne method, the tank method, the transfer method, carbonation; cold maceration; carbonic maceration; thermo vinification; chaptalisation; use of commercial enzyme in wine making.
5. Monitoring and controlling of fermentation parameters of wine: monitoring and viability and cell number of yeast during must preparation, controlling microbial growth during wine production, effect of pH, temperature, CO<sub>2</sub>, amount of sugar consumed.

### Section-II

6. Clarification & stabilization of wine- Clarification- proteins, polyvinyl polypyrrolidone & bentonite; Tartaric acid, tartarate & wine stability- static cold stabilization, contact cold stabilization, ion exchange stabilization, estimation of



- cold stability, prevention of crystallisation, protein instability, assessment of heat (protein) stability.
7. Preservation of wine- sulphur dioxide, dimethyl dicarbonate, sorbic acid & benzoic acid.
  8. Maturation & aging- Sur Lie storage of wine, Oak Barrel & wine, maturation reactions in red wine, Micro-oxygenation, corks.
  9. Fortified wines- Fortification, port, Vins Doux Naturels (VDN), Madeira, Sherry, Commandaria.
  10. Barrels: French Oak Forest; Stave wood; Barrel making; Barrel maturation.

### 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.

## WT 2.4 Chemical and Plant Engineering-I

### Section-I Chemical and Plant Engineering

1. Principles of distillation Vapour liquid equilibrium, boiling point, and diagram. Basic principle of distillation – Pot and coffee stills conventional/ continuous distillation system.
2. Introduction study of elementary chemical engineering concepts. Classification of chemical process. Material balance with and without chemical reaction, process calculation involving various unit operations.
3. Fluid flow fundamentals. Laminar and turbulent flow. Bernoulliz theorem and its applications, Friction factor pump selection and applications.
2. Heat transfer fundamentals, types of heat exchange, design of heat exchange equipments and their application to distillery industry.
5. Steam Generation, Characteristics of steam, use of steam to process industry, introduction and types of boilers, feed water treatment.
6. Fuels and combustion, classification of fuels, gross & net calorific value, principles of combustion.
7. Power generation and utilization, sources of power generation, Classification of turbines, Basic principles of Electrical Engineering.

8. Pumps and their application, characteristic curves, types of pumps, (maintenance of pumps and operation).
9. Use of compressed air for process industry, compressor and its working principles.
10. Engineering materials- types of materials, their properties and uses.
11. Refrigeration, cooling and chilling plants

**Reference Books:**

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

**Section-II Instrumentation:**

1. Introduction to Instrumentation, important terms associated with instruments such as range, span, accuracy, error, and sensitivity.
2. Flow measurement - Basic terms such as total flow, volumetric flow, Mass flow, viscosity, Reynolds number, types of flow, flow transducers such as orifice plate, pitot tube, flow nozzle, anubar, venturi meter, variable area flow meter, rotameter, magnetic flowmeter, coriolis mass flow meter, vortex flowmeter, ultrasonic flowmeter, turbine flowmeter, displacement flowmeter
3. Temperature measurement - Introduction to filled system thermometers, expansion thermometers, thermocouples, RTD's, Thermistors and pyrometers.
4. Pressure measurement - Various units and their conversion, manometers, Bourdon tube, diaphragm, bellows, capsule, strain gauges for pressure measurement.
5. Level measurement - Direct methods such as float method, magnetic level indicator, magnetic level switches, indirect methods such as hydrostatic method, radiation method, ultrasonic method and capacitance method.
6. pH and conductivity measurement - Introduction, different types of sensors, pH meter and conductivity meter.
7. Polarimetry - Laurentz polarimeter, industrial polarimeter, white lamp single wedge/double wedge polarimeter, automatic polarimeter.
8. Refractometry - Hand refractometer, Abbe's refractometer.

**Reference Books:**

1. *Instrument Engineers handbook – Process measurement by BG Liptak*
2. *Process Instrumentation & Control by A. P. Kulkarni*
3. *Process Control Instrumentation Technology by C. D. Johnson.*
4. *Instrumental methods of analysis by Willard, Merrit & Dean.*

### WT 2.5 Practical- I:

1. Sampling & grading of barley. And Preparation of sample of barley for chemical analysis.
2. Determination of Moisture & Extract content of barley.
3. Study of germination of barley.
4. Determination of Specific Gravity & Extract of wort.
5. Determination of Reducing sugar content of wort.
6. Determination of Fermentable saccharides of wort.
7. Determination of pH & acidity of wort.
8. Sampling & physical tests of malt.
9. Determination of moisture content of malt.
10. Determination of extract content of malt.
11. Determination of ethanol content of spirit sample by oxidation method.
12. Determination of fermentation efficiency of yeast growing on molasses medium.
13. Determination of total & fixed volatile acidity of rectified spirit (ISI method)
14. Determination of volatile acidity of rectified spirit (ISI method)
15. Determination of aldehyde content of Rectified Spirit (AOAC Method)
16. Determination of ester content of Rectified Spirit (AOAC Method)
17. Determination of fusel oil content in spirit sample.
18. Determination of furfural content in spirit sample.
19. To conduct potassium permanganate test for finding the quality of spirit.
20. Determination of fermentation efficiency of yeast growing on molasses medium.
21. Preparation of wine from grapes.
22. Determination of total reducing sugar of wine production.
23. Determination of pH & total acidity of wine.
24. Determination of Volatile acidity of wine by Sellier's method.
25. Determination of free & total Sulphur dioxide of wine.
26. Determination of ethanol content by ebulliometry.

## 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, CO<sub>2</sub> 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. CO<sub>2</sub> /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 (8<sup>th</sup> 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 -2<sup>nd</sup> 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 7<sup>th</sup> 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 Co<sub>2</sub>, 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 4<sup>th</sup> 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 2<sup>nd</sup> 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- SO<sub>2</sub>, 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- SO<sub>2</sub>, Antioxidants, Antiseptic, Antioxidasic, Free & total SO<sub>2</sub>, Molecular SO<sub>2</sub>, 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 50<sup>th</sup> 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. 4<sup>th</sup> 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.