Savitribai Phule Pune University

(Formerly University of Pune)

Two-Year M.Sc. Degree Program in Wine, Brewing and Alcohol Technology

(Faculty of Science & Technology)

Syllabus

(For Colleges Affiliated to Savitribai Phule Pune University)

Choice Based Credit System
Syllabus

To be implemented from Academic Year 2019-2020

Preamble:

Wine Technology, being one of the youngest branch of Life Science, has expanded and established as applied science. Global and local focus has slowly shifted to not only current "Century of Knowledge" but also on to technology development and application in life sciences. Although, wine has traditionally been consumed throughout history with evidence dating back to Harappa civilization, commercial wine production is a pretty recent phenomenon, with the first commercial grape wine plant being set up only in the 1980s. Since then, three major players – Chateau Indage, Grover Vineyards and Sula Vineyards – emerged in the domestic winemaking scene and the last few decades saw vineyards cropping up all over thecountry.

Then came the tide of globalization and India, bowing to WTO's demands, had to reduce tariffs on imported liquor with the consequence that the market was suddenly flooded with incredibly refined Italian and French wines of unmatched quality – much to the delight of the wine lovers and to the woe of the Indianwinemakers.

Coming back to the present times, finding a foothold in an arena that has been eternally dominated by European players (read: France, Italy, and Spain, in that order) has been quite an uphill task for Indian winemakers. However, the recent growth numbers – the wine market is currently growing at a rate of 25-30 per cent – have given them some cause to celebrate. A larger market translates to more demand, which in turn means that Indian wines can, now, share a shelf with their French and Italian counterparts. Moreover, Indians wines are considerably cheaper than their Western counterparts; thus, enabling it to achieve a particular target audience of itsown.

Back home, statistics reveal that India's rich and prosperous are finally warming up to this delicious drink; India has a wine market of roughly 1.2 million cases, while experts predict that consumption will grow at a CAGR of around 30% during 2009-2013. Lastly, right marketing strategies and increased awareness will go a long way to ensure that this historically significant drink finally conquers Indianhearts.

Introduction:

The syllabi till today had been sufficient to cater to the needs of students for building up their careers in industry and research. However, with the changing scenario at local and global level, we feel that the syllabus orientation should be altered to keep pace with developments in the education and industrial sector. The need of the hour is to design appropriate syllabi that emphasize on teaching of technological as well as the economic aspects of Wine, Alcohol and Brewing industry. Theory supplemented with extensive practical skill sets will help a graduate student to avail the opportunities in the applied fields (research, industry or institutions), without any additional training. Thus, the university / college itself will be developing the trained and skilledmanpower.

Objectives to be achieved:

- To introduce the concepts in various alliedsubjects
- To enrich students'knowledge
- To help the students to build interdisciplinaryapproach
- To inculcate sense of scientific responsibilities and social and environmentawareness
- To help students build-up a progressive and successfulcareer.

Eligibility: Candidates applying for M.Sc. for wine technology should be B. Sc. in Wine Technology/ Post Graduate Diploma in Industrial Fermentation and Alcohol Technology/ B.Sc. in Bio-Technology Microbiology/ Chemistry/ Agriculture/ Botany/ Zoology/Agricultural Bio- Technology and B.E. /B. Tech. (Chemical Engineering/ Biotechnology/food)

SPECIAL FEATURES
1. More stress will be given to this process development and scale-up system along with marketing. 2. Evaluation of waste for production of valuable products will be given primeimportance 3. Energy Production and Conservation will be considered during the tenure of thecourses. 4. Industry attached Educational system, is more feasibleconcept
Career Opportunity
1. Government sector in India
-Agriculture departments
-Agriculture Institute
-Excise Department
-Bureau of Indian Standards
-Import Export Departments
2. International and national wine making plant
-Vineyard management and marketing services
-Research techniques
-Technical assistance
-Winery laboratory technicians
-Wine marketing services
-Quality control in wine industry.
3. Self employment
-own winery
-winery consultant
-wine taster, wine maker

Course Structure:

Semester I

Course code	Course Title	Credits
Core Compulsory Theory Papers (CCTP)		
WT 1.1	Viticulture	4Credits
WT 1.2	Microbiology of Alcohol, Beer and Wine	4Credits
WT 1.3	Biochemistry of Alcohol, Beer and Wine	4Credits
Core Compulsory Practical Paper: CCPP-1		
WT 1.4	Practical Course –I - Practical's based on microbiology andbiochemistry	4Credits
Choice Based Optional Papers: CBOP (any One)		
WT 1.5	Fermentation technology	2Credits (Th)
WT 1.6	Practical Course – II	2 Credits (Pr)
Total		20 Credits

SemesterII

Course code	Course Title	Credits
Core Compulsory Theory Papers (CCTP)		
WT 2.1	Alcohol Technology-I	4 Credits
WT 2.2	Brewing Technology-I	4 Credits
WT 2.3	Enology-I	4 Credits
Core Compulsory Practical Paper : CCPP-1		
WT 2.4	Practical Course - I Practical based on alcohol, brewing and alcohol technology	4 Credits
Choice Based Optional Papers: CBOP (any One)		
WT 2.5	Chemical and Plant Engineering-I	2Credits (Th)
WT 2.6	Practical Course - II	2 Credits (Pr)
Total		20 Credits

Semester III

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

Semester IV

Course code	Course Title	Credits
Core Compulsory Theory Papers (CCTP)		
WT 4.1	Industrial waste treatment & Environmental management	4 Credits
WT 4.2	Business Management	4 Credits
WT 4.3	Chemical and Plant Engineering-II	4 Credits
Core Compulsory Practical Paper : CCPP-1		
WT 4.4	Research Project (Which will be of individuals/groups/In plant training)	4 Credits
Choice Based Optional Papers: CBOP (any Two)		
WT 4.5	Alcohol Technology- III	4Credits (2T + 2P)
WT 4.6	Brewing Technology- III	4Credits (2T + 2P)
WT 4.7	Enology- III	4Credits (2T + 2P)
Total		**20 Credits**

Semester I

Course Code: WT 1.1: Viticulture (4 Credits = 60 Lectures)

Units	Topics	No. of Lectures
I	Soil and climate for viticulture: Introduction, Definition; i. Physical properties of soil: Soil colour, texture, thickness of topsoil, soil water andTopography. ii. Chemical properties of Soil: soil pH, nutrients, salinity, soil carbonate, Major type of soil in Maharashtra, Paedogenesis, Soilprofile. iii. Soil management: The role of soil in root growth, soil moisture, soil air, soil temperature, organic matter and biological factor; Climate: Light, Temperature, Air, Rainfall, Humidity, carbon dioxide and effect of climate at different growth stages (dormant period, bud burst period, flowering, post setting and harvestperiod)	15
II	Siteselection,Grapevineplantingmaterials&Propagation: i. Site selection: Macroclimate, microclimate, what is site selection, irrigation, water supply, climate, soil, vegetation analysis and otherfactors. ii. Planting material: Introduction, sanitary selection, disease elimination, genetic selection' iii. Grapevine propagation: Selection of cuttings, treatment & storage, propagation by layering, propagation of grafted vines: bench grafting, budding, micrografting.	15
III	Vineyard establishment, Grapevine pests and diseases: i. Vineyard design: Initial planning, roads, blocks, rows, spacing; Planting: planting of rootings, timing of planting; care of young vine: irrigation, nutrition, weed control, pest; training of young vines, pruning: definition, Aim of pruning, principles, types of pruningprocedure. ii. Grape vine pest: Light brown apple moth, Grape vine moth, Grape Phyllo era, Fruit flies,Thrips. iii. Fungal diseases: Downey mildew, Powdery mildew, Anthracnose, Botrytis rot. iv. Bacterial diseases: Pierce's disease, Crown gall; Viral diseases: Grapevine Leaf-roll, Fanleafdegeneration	15

IV	Developmentstagesofgrapes,Harvesting,Post-harvestmanagement& Scenario of grapes: i. Differences between Muscadine grapes &Evatis species, Berry structure, Development stages of the grape, flavour and aroma compounds of the mature grape, phenolic compound ingrape. ii. Harvesting operation, mechanical harvesting and drying of grapes:Maturity standard, harvesting periods,packing. iii. Postharvest handling, processing, transportation and marketing; Leading grape and wine countries in the world, Grape production scenario of India and major states in India, statistical data of grape production in global and Indian scenario iv. Biotechnological tools to access genetic purity and diversity. Applications of genetical control mechanism in grapes development. Development of grape varieties resistant to various biotic and abiotic stresses.	15

Reference Books:

01. Seattle: American Society for Enology andViticulture
02. Phil Nicholas, Peter Magarey, Malcom Wachtel: Diseases andPests
03. P.R. Dry & B.G. Coombe: Resources-ViticultureVolume-I
04. P.R. Dry & B.G. Coombe: Practical-ViticultureVolume-II
05. John Kent & Richard Early: Pesticide applications inVineyards
06. Robert E. White: Soil for finewines
07. Andrew markides& Richard Gibson: Australian Society of Viticulture&Enology
08. Donald L.Flaheherty, L. Peter Christensen, W. Thomas Lalini, James J. Marosis, Phil A. Philips, Lloyd T. Wilson: Grape pestmanagement
09. Prof. Ralph E. Kunkee: Introduction to wine making-Viticulture andEnology-3.
10. Konig Helmut: Biology of microorganisms on grapes, in must and wine

Semester I

Course Code: WT 1.2:Microbiology of Alcohol, Beer and Wine (4 Credits = 60 lectures)

Units	Topics	No. of Lectures
1	**Classification of microorganisms, staining techniques and Cell biology:** i. Occurrence, types of microorganisms. Classification of microorganisms: bacteria, fungi, viruses, protozoa and algae, difference between prokaryotic and eukaryotic cells, Detail classification offungi. ii. Stain and staining procedures – Definition of stain and dyes, types of stain; procedure and mechanism of Gram staining, Acid fast staining. Negative staining. iii. Detailed study of bacterial cell organelles, cell wall, cell membrane, capsule, endospore, flagella, types of flagella, mechanism of flagellarmovement. iv. Growth: Definition of growth, factor affecting the growth curve, measurement of growth, continuous culture, chemostat, turbidostat, dialysis technique, synchronousgrowth.	15
2	**Basic techniques in microbiology:** i. Sterilization & Disinfections: Definition of sterilization & disinfections; physical agents – application of high temperature & low temperature for killing microorganisms (Moist heat & dry heat). Low temperature, Refrigeration or Subzero temperature, Desiccation, Osmotic pressure, Radiation, U V light, X-ray, gamma rays & cathode rays, filtration (Bacteriological filter, Air filters), HEPA filters, ultrasonic & washing. Chemical agents – characteristics of ideal disinfectant, selection of chemical antimicrobial agents – phenol & phenolic compounds, alcohol, halogens, heavy metals & their compounds, detergents, aldehydes, gaseous & chemo sterilizers. ii. Nutrition: Autotrophic, heterotrophic & photosynthetic organisms, uptake of nutrients. Pure culture techniques enrichment culture technique, design & preparation of media – Nutritional requirements ingredients of media, types of media. Preservation of pure culture and their techniques, slantculture preservation, Lyophilization.	15

3	**Microbiology of yeast:** i. Definition, comparison with other microorganisms, yeast morphology and taxonomy,yeastcellstructureandfunctionsofvariouscellularcomponents. ii. Nutritional requirements of yeast, Aerobic and anaerobic metabolic pathways in yeast for sugar dissimilation, Isolation and Maintenance of yeast, Staichiometry of alcoholproduction.	15

4	**Industrially important fermentation products:** i. Role of fungi in various fermentations, Examples of various fermentations using yeast with special reference to Glycerol, baker's yeast,etc. ii. Comparison of solid-state fermentation with other types of fermentations, Importance of solid-state fermentation, the industrial production of various SSF basedproducts. iii. Contamination control in alcoholic fermentations Introduction to antibiotics, Mechanism of various antibiotics, Effect of microbial contaminants on alcoholic fermentations. Role of antimicrobial substances controlling contamination in alcoholic fermentation,	15

References:

1. Casida L. E. (Jr) (1993) Industrial Microbiology, 5thReprint
2. Patel A. H.(2005) IndustrialMicrobiology.
3. Michael J. Pelzer, E.E.S. Chan, Noel R. Krieg (1993)Microbiology
4. P. Gunasekaran (2005) Laboratory Manual inMicrobiology
5. Lansing M. Prescott John P. Harley & Donald A. Klein (2005)Microbiology
6. Rojer A. Stanier (1989) GeneralMicrobiology
7. Pawar C. B. & H. F. Daginawala (1982) General MicrobiologyVol.-2
8. Stanbury, P. F., Whitaker A. & Hall S. T.(2008) Principles of Fermentation Technology 9 Panda U. N. (2005) Handbook of Microbiology andparasitology
10. Anuradha De. (2009) Practical and appliedmicrobiology
11. Prescoff Hurley Kline's (2008)Microbiology
12. Sathe S. T. Pharande S. R.(2010) Introduction toMicrobiology

Semester I

Course Code: WT 1.3: Biochemistry of Alcohol, Beer and Wine (4 Credits =60 lectures)

Units	Topics	No. of Lectures
1	**Basic Biochemistry of living cells:** i. Introduction to Biochemistry, Concept & scope of Biochemistry, Application of biochemistry in winescience ii. Water: Types of bond, Covalent and non-covalent interactions in biomolecules with suitable example, functional groups and modification of functional group relevant to biomolecules. Properties of water, Hydrogen bonding, ionization of water, interaction of biological molecules in water, osmosis iii. Buffers - Biological buffers-concept, types and theirimportance. iv. Photosynthesis: Definition, importance and mechanism, light reaction, Dark reactions and factors affecting the photosynthesisrate.	15
2	**Proteins,carbohydrates and lipids:** i. Characteristics and classification of proteins, protein structure and proteins in sugarcane juice. Amino Acids: Classification and properties, amino acids in sugarcane juice andmolasses. . ii. Classification of carbohydrates, Examples and structures of various carbohydrates, Important carbohydrates for production of alcohol, beer and wine. Glycolysis, TCA cycle, Pentose Phosphatepathway, Glyoxylate cycle. iii. Metabolism of amino acids. Definition, nomenclature, classification - (simple, complex, derived lipids - structure & example) phospholipids, glycolipids, - (structure,composition).	15
3	**DNA and Chromosomes:** i. DNA as the molecule of information: DNA as the genetic material and its organization. DNA structure, Purine, pyrimidine - definition and structure. Nucleoside, nucleotide: definition and structure. Chemical Properties: Hydrolysis (acid, alkali), enzymatic hydrolysis ofDNA. ii. DNA replication and it's regulation. DNA damage andrepair. iii. Chromosomes: Structure and shapes ofmetaphase chromosomes histone, non-histone proteins Nucleosome and packing of DNA into chromosome .	15

4	**Biochemistry of alcoholic fermentation &Maloalcoholic Fermentation:**i.Pathways involved in alcoholic fermentation, Transport of carbohydrates in yeast.Inter relationship between sugar uptake during alcoholic fermentation (Pasteurand Crabtree Effect). ii.Concept of Maloalcoholic fermentation and its on harmonious balance taste,various strains used in Malolactic fermentation (MLF) , Malolactic fermentation (MLF) beneficial and deleterious aspects of malic acid biodegradation. **iii.**Production of biogenic amines & ethyl carbamate Usage & formation of Sulphur compound. Microbial formation & modification of flavor & off-flavor compounds in wine. Exoenzymes of wine microorganisms.	15

References:

1. Keith Wilson (2005) Practical Biochemistry Biology Principles &Techniques
2. Deb A. C.(1999) Concepts of biochemistry (Theory &Practical)
3. Lehninger Albert L.(1984)Biochemistry
4. David L. Nelson & Michael M.(2005) Lehninger principles ofBiochemistry
5. Sadasivam S. & Manickam A.(2010) BiochemicalMethods
6. Gurdeep P.Chaiwal& sham K. Anand (2007) Industrial methods of chemicalAnalysis
7. Deb A. C.(2004) Fundamentals ofbiochemistry

Coursecode:WT-1.4PracticalCourse-I:Practical'sbasedonmicrobiologyandbiochemistry 4 Credit Course (Total Practical=30)

Sr.No.	Topic	No. of practical
1	Safety Measurement and good Lab Practices	1
2	Basic Learning Techniques in Microbiology Laboratory	1
3	Preparation of Culture media and Sterilization	1
4	Preparation of Nutrient media and Morphological identification ofLAB	1
5	Preparation of Nutrient media and Morphological identification of yeast	1
6	Isolation of micro-organism by four quadrant technique	1
7	Isolation of micro-organism by T-Streaking technique	1
8	Enumeration of micro-organism by Spread Plate Technique	1
9	Enumeration of micro-organism by Pour Plate Technique	1
10	Yeast Enumeration with help of Neubaur chamber	1
11	Wet mount preparation of water and fermenting wine sample	1
12	Monochrome staining and Negative Staining	1
13	Gram staining	1
14	Hanging drop method for motility	1
15	Preparation of slide culture method	1
16	Estimation of protein by Biuret method	1
17	Estimation of protein by Lowary method	1
18	Preparation of buffers and desired pH, Molarity, Normality- Acetate buffer and Phosphate buffer	1
19	Determination of reducing sugar by DNSA	1
20	Determination of total viable count of yeast from wine	1
21	Immobilization of yeast cell	1
22	Estimation of enzyme activity – amylase	1
23	Determination of specific activity -amylase	1
24	Determination of proteolytic activity of yeast strain	1
25	Paper chromatography of amino acid	1
26	Good practices in yeast handling	1
27	Effect of salt concentration, temperature, pH	1
28	Identification of wine spoilage, by phenotypic and biochemical methods	1
29	Detection of sugar (Benedicts\ Felhings),detection of starch, difference between reducing and non reducing sugars.	1
30	Demonstration of fermentation by using yeast.	1

Semester I

Course Code: WT -1.5 Fermentation technology (4 Credits = 60 lectures)

Units	Topics	No. of Lectures
1	1.1 Scope and importance offermentation 1.2 Configuration offermenter 1.3 Types of fermenter : Batch fermenter, Continuous, Stirred tank, Tubular Fermenter, Fluidised bed fermenter, Bed fermetner, Solid state fermenter, Hollow fibrefermenter 1.4 Sterilization : Introduction, Media Sterilization, Design ofbatch Sterilization processes, Sterilization of fermenter, Filter sterilization.	15
2	2.1 Development of Inoculum for industrialfermentation 2.1.1 Criteria for transfer ofinoculums 2.1.2 Development of inoculums for yeastprocesses 2.1.3 Development of inoculums for bacterialprocesses 2.1.4 Development of inoculums for mycelialprocesses 2.2 Production of media 2.2.1 Characteristics of ideal production media 2.2.2 Raw materials : Saccharine material, Starchy material, Cellulosic Hydrocarbon and vegetable oils, Nitrogenousmaterial 2.2.3 Composition of grape juice as fermentation on medium with respect To source 'C', 'N', Amino acid, Vitamins, Minerals, pH, Water, Buffering capacity, Additives used in winefermentation. 2.2.4 MediaOptimization.	15

Reference books –

1. Industrial Microbiology- A.H.Patel(2008)
2. Principal of Fermentation Technology- Peter stanbuzy, A.Whitaker(2008)
3. Industrial Microbiology-L.E.Casida
4. Fermentation Technology-M.L.Srivastava
5. Biotechnology –B.D.Singh

Course code: WT 1.6

Practical Course -II 2
Credit Course
(Total Practicals15)

Sr.No.	Topic	No. of practical
1	To do analysis of particle size of the soil sample	1
2	To determine water holding capacity of soil sample	1
3	To determine temperature and pH of the soil sample	1
4	To determine total alkalinity of the soil sample by titration method	1
5	To determine chlorides and sulphates of the soil sample	1
6	To determine organic matter content of the soil sample	1
7	To study the anatomical features of stem of grapevine	1
8	To study pruning technique of grapevine	1
9	To learn grafting technique used in grapevine	1
10	To study and observe pest attack on grapevine	1
11	To study Downy mildew on infected leaves of grapevine	1
12	To do analysis of water sample	1
13	To visit vineyard and to submit a report on the basis of their observation	3

Course Code: WT 2.1 : Alcohol technology (4 Credits = 60 lectures)

Units	Topics	No. of Lectures
I	**Yeast maintenance and propagation 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-fermentaion practices adopted for yeast propogation prior to inoculation to main fermenter. Prefermenter (Blue) design; material of construction and its maintenance. Use of sterile air/sparging system in Pre-fermenter.	15
II	**Raw material for alcoholic fermentation and its manufacturing** Introduction to first and second generation of ethanol. Introduction to various feedstock for alcohol fermentation-grain, sweet sorghum, sugarbeet, rice, maize, bajara, wheat, dates, cashewapple. Overview of Molasses composition, grades, storage and cost. Details of molasses weighing system. Molasses dilution practices adopted and design of diluter, quality of dilution water used, Quality of water and molasses dilution practices. Pre clarification of molasses advantages and drawback, molasses sterilization/pasteurization.	15
III	**Details of alcoholic fermentation** Definitions of various terms related to alcoholic fermentation, 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. Alcoholmetry – proof spirit (British and USA) over proof, under proof, specific gravity of alcohol strength of alcohol in terms of concentration – related examples and solution. Prevention of losses of alcohol during fermentation, post – fermentation practices/scrubbing etc. Post clarification of fermented wash; advantages and disadvantages.	15
IV	**Chemistry of alcohol** What is alcohol? Physical and chemical properties of alcohol; Classification of alcohols, Important chemical reactions of alcohol; Production of alcohol by synthetic method. Uses of alcohol. **Alcohol based chemicals** Detail study of reactions involved, manufacturing process, uses, list of manufacturers-Acetaldehyde, Acetic acid, Acetic-Anahydride, Butanol, Ethyl acetate, Butyl acetate, acetone, Ethyl ether, Diethyl oxalate.	15

Reference Books:

1. The Alcohol Textbook –W.M.Inledew.
2. Handbook of Alcohol beverages - by AlanBuglass.
3. HandbookofFermentationandDistillation–A.C.Chatterjee.
4. Distillation Engineering handbook by Parthasarathichattopadhyay
5. Malt whisky - by Charlesmaclean
6. Distiiledspiritsproduction,technology,innovation–byJ.H.Bryce,J.R.Piggott

Course Code: WT 2.2 : Brewing technology -I (4 Credits =60 lectures)

Units	Topics	No. of Lectures
1	**History and overview 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. An overview of Brewing: Introduction, outline o the Brewing steps, Malting, Milling and Adjunct Use, Mashing, Wort separation, Wort boiling, Trub removal, Wort cooling/Aeration, Yeast handlin Yeast pitching, Fermentation, Yeast removal, Aging, Clarification, packaging and warehouse practices. **Beer origin, classification and 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.	15
2	**Basic raw materials of brewing – Water** i.Brewery water consumption ii. Brewery Water Categories iii. Water hardness, water alkalinity & pH effect of ions in water iv. Inorganic Constituents and organic constituents of Water v. Water quality reports parameter – primary standards, secondary standards & aesthetic standards. vi. Chemical Characterization of water types v.Summary of the Influences of Various Ions during Beer Production 2hr	15

3	Basic raw materials of brewing – Hops and Adjuncts i.HopClassification,hopcultivation, hopharvesting ii. Hops chemistry -Hops- Hop chemistry, whole Hops, Hop Resins, Soft Resins, Hard Resins, Hop oils iii. hop products – Benefits of hops products, classification of hops product iv.Hops usage - Choice of Hop Product , Hop Utilization , Calculation of Hop Additions v.Adjuncts: concept, role of adjuncts in brewing, various example of adjuncts	15

4	Basic raw materials of brewing – Barley and malt yeast i. BarleyandMalt:-Barley–Structureandfunction:thehuskthepericarp,testa, Aleurone Layer, Starchy Endosperm, The Embryo. 3hrs ii. Malt Production: Drying, Storage, and Handling, steeping, Germination, Kilning and Malt Quality, Malt varieties 3hrs Yeast iii. Brewer yeast, Commercial brewery propagation, yeast handling, yeast collection	15

Reference Books:

1. A History of Beer & Brewing by Tan S.Harnesey.
2. Brewing engineering by Stevendeeds.
3. Brewing by Michel j. lewis, tom w.young
4. Water a comprehensive guide for brewers by Johnpalmer
5. Yeast the practical guide to beer fermentation by chris white with jamilzaiansheff
6. Malt a practical guide from field to brewhouse by johnmallett
7. Hops by stan hieronymus

Semester II

Course Code: WT 2.3: Enology -I (4 Credits = 60 lectures)

Units	Topics	No. of Lectures
I	History and classification of wine i. Introduction: History of wine making, present international and national status of wine production, nutritional and therapeutic value of wine, commercial aspect of wineproduction. ii. Classification of wine- table wines, sparkling wine, dessert wines, aperitif wine, pop wine Nutritional and health aspects of wine iii. Chemical contents of grapes and wine in relation tonutrition iv. Contribution of Antioxidant with respect to human health, List of diseases cured by wine. v. Comparison of Red, white and sparkling wine at nutritional point of view. Overview of world and Indian wine scenario: vi. Major wine producing countries in the world. vii. The current and future wine prospectus in India New concept of wine production: organic, biodynamic wine, Ice wine, etc	15
II	i. Principal constituents of grape juice andWine: Water, Carbohydrates (Sugar), Acid, Nitrogen containing compounds Mineral Salts, Phenolic compounds and Related Phenol-Tannins, Anthocyanins, Alcohols, Higher alcohols, dissolved gases, Some Important Functional and Chemical Groups in Grapes. ii. Grapes: To Provide an overview of White wine grapes varieties To Provide an overview of red wine grape varieties To Provide an overview of Sparkling wine varieties and styles. iii. Pre-fermentationtreatments: must preparation, must adjustments , Clarification of grape juice and use of commercial enzyme in wine making,	15

III	**Production:** i. Detailed Red wine production stages - harvesting tobottling ii. Detailed White wine production stages - harvesting tobottling iii. Sparkling wine production stages - Traditional method, transfer process method, Tank method andCarbonation.	15
IV	i. Basic biochemistry of alcoholicfermentation ii.Monitoring and controlling of fermentation parameters of wine: monitoring and viability and cell number of yeasts during must preparation, controlling microbial growth during wine production, effect of pH, temperature, CO2, amount of sugar on fermentationrate iii. Role of sulphur-di-oxide invinification iv. Preservation of wine- sulphur dioxide, dimethyl dicarbonate, sorbic acid & benzoicacid.	15

Recommended Textbooks and References for Wine technology:

1) Pascal Ribereau , (2000) Hand book of enology volume–I
2) Ron s. Jockson (2000) Wine science principles practices &perception
3) Brue W. Zoecklein, Kenneth Fugelsang, Barry H. Gump Fred S. Nury (1999) Wine Analysis and production
4) C. S. Ough (1992) Wine makingBasics
5) Roger B.Boulton (1996) Principles and practices of winemaking
6) Emile Peynalld (1984) Knowing & makingwine
7) Patrice Iland& Peter Gago (1997) Australian wine from the grasp vine to theglass
8) Brue W. Zoecklein (1999) Wine Analysis andproduction

Semester II

Course Code: WT 2.5: Chemical and plant engineering -I (2Credits)

30 lectures

Units	Topics	No. of Lectures
I	**Fundamentals of distilleries-** Principles of distillation Vapour liquid equilibrium, boiling point, and diagram. Basic principle of distillation – Pot and coffee stills conventional/ continuous distillation system. 2. Heat transfer fundamentals, types of heat exchange, design of heat exchange equipments and their application to distillery industry	10
II	**Pressure, flow, temperature and flow measurement** Introduction to Instrumentation, important terms associated with instruments such as range, span, accuracy, error, resolution, accuracy, reproducibility, repeatability, and sensitivity. Various pressure units and their conversion, pressure transducers such as barometer, manometers, Bourdon tube, diaphragm, bellows, capsule, strain gauges for pressure measurement. Flow measurement Basic terms such as total flow, volumetric flow, Mass flow, types of flow, flow transducers such as orifice plate, pitot tube, flow nozzle venturi meter, variable area flow meter, magnetic flowmeter, coriolis mass flow meter, vortex flowmeter, ultrasonic flowmeter, turbine flowmeter, displacement flowmeter. Temperature measurement Various scales and conversion, Introduction to filled system thermometers, expansion thermometers, thermocouples, Resistance temperature detector, Thermistors and pyrometers. Level measurement Direct methods such as gauge glass method, float method, magnetic level indicator, magnetic level switches, indirect methods such as hydrostatic method, radiation method, ultrasonic method and capacitance method.	20

Semester II

Course code: WT 2.4: Practical Course – II(4Credit Course -Total Practical=30)

Sr.No.	Topic	No. of practical
1	1. Sampling & grading ofbarley. 2. Preparation of sample of barley for chemicalanalysis. 3. Determination of Moisture & Extract content ofbarley. 4. Study of germination ofbarley. 5. Determination of Specific Gravity & Extract ofwort. 6. Determination of Reducing sugar content ofwort. 7. Determination of Fermentable saccharides ofwort. 8. Determination of pH & acidity ofwort. 9. Sampling & physical tests ofmalt. 10. Determination of moisture content ofmalt. 11. Determination of extract content ofmalt. 12. Determination of ethanol content of spirit sample by oxidationmethod. 13. Determination of fermentation efficiency of yeast growing on molasses medium. 14. Determination of total & fixed volatile acidity of rectified spirit (ISI method) 15. Determination of volatile acidity of rectified spirit (ISImethod) 16. Determination of aldehyde content of Rectified Spirit (AOACMethod) 17. Determination of ester content of Rectified Spirit (AOACMethod) 18. Determination of fuel oil content in spiritsample. 19. Determination of furfural content in spiritsample. 20. To conduct potassium permanganate test forfinding the quality of spirit. 21. Determination of fermentation efficiency of yeast growing on molasses medium. 22. Preparation of wine fromgrapes. 23. Determination of total reducing sugar of wineproduction. 24. Determination of pH & total acidity ofwine. 25. Determination of Volatile acidity ofwine 26. Determination of free & total Sulphur dioxide of wine. 27 Determination of moisture and ash content ofmolasses. 28 Determination of total solids and suspended solids ofmolasses. 29 Determination of ethanol content of spirit by specific gravitymethod.	

Semester II

Course code: WT -2.6 Practical Course- II: (2Credit Course -Total Practical =15)

Sr.No.	Topic	No. of practical
1	Measurementof properties of liquids (must, wort, molasses, wine, sugar syrups etc.) using Specific gravity bottle, ^{0}Brix hydrometer, handheld Refractometer	3
2	Calibration of Bimetallic Thermometer	1
3	Calibration of PH meter	1
4	Estimation of thermal death coefficient k for normal wine contaminants	1
5	Practical calculation of refrigeration loads for wine storage	1
6	Filtration of liquids through cake filters, Estimation of flux as a function of ΔP, area, etc calculation of values of α and β in the Darcy equation	1
7	To determine the coefficient discharge using Orifice meter.	1
8	Determination of the heat transfer coefficient for plate type heat exchanger	1
9	Determination of the heat transfer coefficient for Shell and Tube heat exchanger	1
10	Determination of the coefficient discharge using Venturi meter	1
11	Determination of the coefficient discharge using Orifice meter	1
12	To study characteristics of steam distillation.	1
13	To study Rayleigh equation and study simple distillation.	1