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

(Faculty of Science & Technology)

M. Sc.-Part I 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 skilled manpower.

Objectives to be achieved:

- To introduce the concepts in various allied subjects
- To enrich students' knowledge
- To help the students to build interdisciplinary approach
- To inculcate sense of scientific responsibilities and social and environment awareness
- To help students build-up a progressive and successful career.

Eligibility:

B.Sc. in Wine Technology/ Post Graduate Diploma in Industrial Fermentation and Alcohol Technology/ B.Sc. in Bio-Technology/ Microbiology/ Chemistry/ Agriculture/ Botany/ Zoology/ and B.E. /B. Tech. (Chemical Engineering/ Biotechnology)

The students of B. Tech. (Food Technology) B. Sc. (Horticulture), B. Sc. (Hotel Management) and B. Sc. (Agricultural Biotechnology) also be considered eligible students for the M. Sc. (WBAT) course.

Faculty for teaching subjects

Sr. No.	Name of subject	Qualification
1	Marketing of Alcoholic beverages	MBA
2	Business Management	MBA
3	Cyber Security	B. E. (Electronics)
4	Human Rights	MBA

Course structure
Semester-I

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

Semester-II

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

Semester-III

Course code	Course title	Credits
Core Compulsory Theory Papers (CCTP)		
WT 3.1	Alcohol Technology-II	4
WT 3.2	Brewing Technology-II	4
WT 3.3	Enology-II	4
Core Compulsory Practical Paper: CCPC-1		
WT 3.4	Practical Course-I-Practical's based on alcohol, brewing and wine technology	4
Choice Based Optional Papers: CBOP		
WT 3.5	Marketing of alcoholic beverages	2(Th)
WT 3.6	Practical Course-III	2(Pr)
Total		**20**

Semester-IV

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

M Sc. - I
Semester-I
WT 1.1 Viticulture (4 Credits = 60 Lectures)

Credit No.	Credit title	Total hours per credit
1.11	Soil and climate for viticulture	15
1.12	Site selection, Grapevine planting materials & propagation	15
1.13	Vineyard establishment, Grapevine pests and diseases	15
1.14	Development stages of grapes, Harvesting, Post management & Scenario of grapes:	15
total		60

Details of syllabus

Units	Topics	No. of Lectures
I	**Soil and climate for viticulture:** Introduction, Definition; Physical properties of soil: Soil colour, texture, thickness of topsoil, soil water and Topography. **Chemical properties of Soil:** soil pH, nutrients, salinity, soil carbonate, Major type of soil in Maharashtra, Paedogenesis, Soil profile. **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 harvest period)	15
II	**Site selection, Grapevine planting materials & propagation:** Site selection: Macroclimate, microclimate, what is site selection, irrigation, water supply, climate, soil, vegetation analysis and other factors. **Planting material:** Introduction, sanitary selection, disease elimination, genetic selection' **Grapevine propagation:** Selection of cuttings, treatment & storage, propagation by layering, propagation of grafted vines: bench grafting, budding, micro grafting.	15

III	**Vineyard establishment, Grapevine pests and diseases:** 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: definion, Aim of pruning, principles, types of pruning procedure. Grape vine pest: Light brown apple moth, Grape vine moth, Grape Phyllo era, Fruit flies, Thrips. **Fungal diseases:** Downey mildew, Powdery mildew, Anthracnose, Botrytis rot. **Bacterial diseases:** Pierce's disease, Crown gall; Viral diseases: Grapevine Leaf-roll, Fanleaf degeneration	15
IV	**Development stages of grapes, Harvesting, Post harvest manage 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:

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.3
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.
10. Biology of microorganisms on grapes, in must and in wine- Konig Helmut.

WT 1.2 Microbiology of Alcohol, Beer and Wine

Summary

Credit No.	Credit title	Total hours per credit
1.21	Classification of microorganisms, staining techniques and Cell biology	15
1.22	Basic techniques in microbiology	15
1.23	Microbiology of yeast	15
1.24	Industrially important fermentation products	15
total		60

Detail syllabus

Credit No.	Credit title	No. of lectures
1.21	**Classification of microorganisms, staining techniques and Cell biology** i. Occurrence, types of microorganisms. Classification of microorganisms: Difference between prokaryotic and eukaryotic cells, types of bacteria, fungi, viruses, protozoa and algae. Detail classification of fungi. 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 flagellar movement. iv. Growth: Definition of growth, factor affecting the growth curve, measurement of growth, continuous culture, chemostat, turbidostat, dialysis technique, synchronous growth.	15
1.22	**Basic techniques in microbiology** i. **Introduction of microscopy**. ii. 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	15

	& chemo sterilizers. iii. 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, slant culture preservation, Lyophilization.	
1.23	**Microbiology of yeast** i. Definition, comparison with other microorganisms, yeast morphology and taxonomy, yeast cell structure and functions of various cellular components. ii. Nutritional requirements of yeast. Aerobic and anaerobic metabolic pathways in yeast for sugar dissimilation, Isolation and Maintenance of yeast. iii. Staichiometry of alcohol production.	15
1.24	**Industrially important fermentation products** Role of fungi in various fermentations, Examples of various fermentations using yeast with special reference to Glycerol, baker's yeast, etc. Selection criteria for industrially important microorganisms, Media formulation Inoculum development, Fermentation technology for production of various byproducts	15

Reference Books:

1. Industrial Microbiology -Casida L. E. (Jr) (1993), 5thReprint
2. Industrial Microbiology Patel A. H.(2005).
3. Elements of Microbiology Michael J. Pelzer, E.E.S. Chan, Noel R. Krieg (1993)
4. P. Gunasekaran (2005) Laboratory Manual in Microbiology
5. Microbiology Lansing M. Prescott John P. Harley & Donald A. Klein (2005)
6. General Microbiology Rojer A. Stanier (1989)
7. General MicrobiologyVol.-2, Pawar C. B. & H. F. Daginawala (1982)
8. Principles of Fermentation Technology Stanbury, P. F., Whitaker A. & Hall S. T.(2008)
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
13. General Microbiology – Volume I and II Power and Daginwala
14. Principles of Microbiology – Sanyogita Wadikar
15. Microbial Technology – Papler Vol. I and II
16. Wine Microbiology and Biotechnology- Graham H. Fleet.
17. Production wine analysis- Zoecklein B. W.
18. The yeast- Lodder H. J.
19. The chemistry and biology of winemaking- Hornsey Ian.
20. Wine and beverage- Bell D. A.
21. Microbiology-Prescott

WT 1.3 Biochemistry of Alcohol, Beer and Wine

Summary

Credit No.	Credit title	Total hours per credit
1.31	**Basic Biochemistry of living cells**	15
1.32	**Proteins, carbohydrates and lipids**	15
1.33	**DNA and Chromosomes**	15
1.34	**Biochemistry of alcoholic fermentation and maloalcoholic fermentation**	15
total		60

Detail syllabus

Credit No.	Credit title	No. of lectures
1.31	**Basic Biochemistry** i. Introduction to Biochemistry, Concept & scope of Biochemistry, Applications of biochemistry in alcoholic fermentations. ii. Water: Types of bond, covalent and non-covalent interactions in biomolecules with suitable examples, 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. Typical structure of eukaryotic cell. Fluid mosaic model of cell membrane iii.Buffers - Biological buffers-concept, types and theirimportance. iv. Photosynthesis: Definition, importance and mechanism, light reaction, Dark reactions and factors affecting the photosynthesis rate	15
1.32	**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 and molasses. ii. Classification of carbohydrates, Examples and structures of various carbohydrates, Important carbohydrates for production of alcohol, beer and wine. iii. Metabolism of amino acids. Definition, nomenclature & classification; Lipids: simple, complex, derived lipids - structure & example phospholipids, glycolipids.(structure and composotion)	15
1.33	**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	15

	Properties: Hydrolysis (acid, alkali), enzymatic hydrolysis of DNA. ii. DNA replication and it's regulation. DNA damage and repair. iii. Chromosomes: Structure and shapes of metaphase chromosomes histone, non histone proteins Nucleosome and packing of DNA into chromosome.	
1.34	**Biochemistry of alcoholic fermentation and malolacic fermentation (MLF)** i. Pathways involved in alcoholic fermentation(Glycolysis, TCA cycle, Pentose Phosphate pathway, Glyoxylate cycle,Transport of carbohydrates in yeast. Inter relationship between sugar uptake during alcoholic fermentation (Pasteur and Crabtree Effect) ii. Concept of MLF and its harmonious balance taste, various strains used in 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

Reference Books:

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) Biochemistry
5. Sadasivam S. & Manickam A.(2010) Biochemical Methods
6. Gurdeep P.Chaiwal& Sham K. Anand (2007) Industrial methods of chemical analysis
7. Deb A. C.(2004) Fundamentals of biochemistry
8. West and Todd -Biochemistry
9. Graham H. Fleet Wine Microbiology and Biotechnology.
10. Yair Margalit, James Crum- Concepts on wine chemistry- the wine appreciation guide
11. Patrick ILAND, Nick BRUER, Andrew EWART, Andrew MARKIDES, John SITTERS.Chemical analysis of grapes and wine techniques and concepts-
12. Hornsey Ian.The chemistry and biology of winemaking

WT 1.4 Practical (Conduct any 30 Practical's)

Sr. No.	Title of the practical	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 of LAB	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 for study of life cycle of yeast	1
16	Estimation of protein by Biuret OR Lowary method	1
17	Preparation of buffers of desired pH, Molarity, Normality- Acetate buffer and Phosphate buffer	2
18	Determination of reducing sugar of given sample by DNSA OR Eynon & Lane method	1
19	Determination of total viable count of yeast from wine	1
20	Immobilization of yeast cell OR Protoplast fusion of yeast cell	1
21	Estimation of enzyme activity – amylase	1
22	Determination of specific activity –amylase	1
23	Determination of proteolytic activity of yeast strain	1
24	Good practices in yeast handling	1
25	To study the effect of salt concentration, temperature, pH on given microorganism	3
26	Identification of wine spoilage, by phenotypic	2
27	Detection of total non reducing sugar (Benedicts\ Fehling's) of given sample	1
28	Demonstration of fermentation by using yeast.	1

WT 1.5 Fermentation Technology (2credits = 30 lectures)

Units	Topics	No. of lectures
I	**Scope and importance of fermentation** Configuration of fermenter Types of fermentation-Batch, Continuous, Fed-batch Types of fermenter-Stirred tank, Tubular type, Fluidized bed fermenter, Solid state fermenter, Hollow fibre fermenter. Sterilization-Introduction, Media sterilization, Design of batch sterilization process, Sterilization of fermenter, Filter sterilization.	15
II	**Development of inoculums for industrial fermentation** i. Criteria for transfer of inoculums, ii. Development of inoculums for yeast processes, iii. Development of inoculums for bacterial processes iv. Development of inoculums for mycelia **Production of media:** **i** Characteristics of ideal production media ii. Raw materials –Carbohydrates, starchy material, cellulosic material, hydrocarbon, vegetable oils, nitrogenous material. iii .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 fermentation media. iv.Media optimization	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

WT 1.6 Practical (conduct any 15 practical's)(2credits)

Sr. No.	Practical	No. of practical's
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	2
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	Estimation of hardness of water	1
13	To visit vineyard and to submit a report on the basis of their observation	3

Semester –II

WT 2.1 Alcohol Technology – I

Summary

Credit No.	Credit title	Total hours per credit
2.11	Raw material for alcoholic fermentation	15
2.12	Chemistry of alcohol and alcoholmetry	15
2.13	Yeast maintenance and propagation in distillery	15
2.14	Details of alcoholic fermentation	15
total		60

Detail syllabus

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 – 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
Summary

Credit No.	Credit title	Total hours per credit
2.21	**History and overview of Industrial Brewing**	15
2.22	**Basic raw materials of brewing- water**	15
2.23	**Basic raw materials of brewing –hops and adjuncts**	15
2.24	**Basic raw materials of brewing- barley and malt ,yeast**	15
total		60

Detail syllabus

Units	Topics	No. of Lectures
2.21	**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 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 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

2.22	**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 vii. Summary of the Influences of Various Ions during Beer Production	15
2.23	Basic raw materials of brewing – Hops and Adjuncts i. Hop Classification,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
2.24	Basic raw materials of brewing – Barley and malt yeast i. Barley and Malt:-Barley–Structure and function:the husk ,pericarp, testa, Aleurone Layer, Starchy Endosperm, The Embryo. ii. Malt Production: Drying, Storage, and Handling, steeping, Germination, Kilning and Malt Quality, Malt varieties Yeast iii. Brewer yeast, Commercial brewery propagation, yeast handling, yeast collection	15

Reference Book:

1. American Society of Brewing Chemists, U.S.A.: Methods of analysis of American society of brewing chemists. (8^{th} rev.) U.S.A. American society of brewing chemists, 1996.
2. Arntzen,C.J.,ed.: Encyclopedia of agricultural science, vol. 1: - A - D. N. York, Academic Press, 1994.
3. Birch,G.G.: Alcoholic beverages. London, Elsevier Applied Science Pub.1985.
4. Government of India. Technical Excise Manual. --(663.16GOV)
5. Hardwick,W.A.,ed.: Handbook of brewing. N. York, Marcel Dekker,Inc.,1995.(663.3 HARHAR)
6. Hough,J.S.,Briggs,D.E.,Stevens,R.,Young,T.W.: Malting & brewing science, vol. 2 : hopped

wort & water. London, Champman & Hall, 1982.

7. Pollock, J.R.A., and ed.: Brewing science vol. 1.London, Academic Press, 1979, (663.3POL)
8. Pollock, J.R.A., and ed.: Brewing science, vol. 2. London, Academic Press, 1981. (663.3POL)
9. Prescott, S.C. & Dunn, C.G.: Industrial microbiology. Jodhpur. Agrobios (India), 2002. 81-7754-149-8
10. Priest, F.G.: Brewing microbiology, 2nd ed.. (1996) U.K. Chapman & Hall, 1996. 0412591502--(576PRI)
11. Priest, Fergus G.; & Stewart, Graham G.: Handbook of brewing. (2^{nd}) U.S.A. CRC Press, Taylor & Francis Group, 2006.
12. Tan S.Harnesey- A History of Beer & Brewing
13. Stevendeeds Brewing engineering
14. Michel J. Lewis, Tom W.Young -Brewing
15. John Palmer -Water a comprehensive guide for brewers
16. Chris White, Jamil Zaiansheff -Yeast the practical guide to beer fermentation
17. Johnmallett-Malt a practical guide from field to brewhouse
18. Stan Hieronymus-Hops

WT 2.3 Enology-I
Summary

Credit No.	Credit title	Total hours per credit
2.31	History and classification of wine	15
2.32	Principal constituents of grape juice and wine	15
2.33	Wine making processes	15
2.34	Basic biochemistry of alcoholic fermentation	15
total		60

Detail syllabus

Units	Topics	No. of Lectures
2.31	**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 wine production. 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 to nutrition 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

2.32	**i. Principal constituents of grape juice and Wine:** 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-fermentation treatments: must preparation, must adjustments , Clarification of grape juice and use of commercial enzyme in wine making,	15
2.33	**Production:** i. Detailed Red wine production stages - harvesting to bottling ii. Detailed White wine production stages - harvesting to bottling iii. Sparkling wine production stages - Traditional method, transfer process method, Tank method and Carbonation.	15
2.34	i. Basic biochemistry of alcoholic fermentation 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, CO_2, amount of sugar on fermentation rate iii. Role of sulphur-di-oxide in vinification iv. Preservation of wine- sulphur dioxide, dimethyl dicarbonate, sorbic acid & benzoic acid.	15

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 IIand, Peter Gago.
6. Wine Science- Ron S. Jackson.

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

WT 2.4 Practical- I(conduct any 30 practical's)

Sr. No.	Title of practical	No. of practical
1	Sampling & grading of barley.	1
2	Preparation of sample of barley for chemical analysis.	1
3	Determination of Moisture & Extract content of barley.	1
4	Study of germination of barley.	1
5	Determination of Specific Gravity & Extract of wort.	1
6	Determination of Reducing sugar content of wort	1
7	Determination of fermentable saccharides of wort.	1
8	Determination of pH & acidity of wort.	1
9	Sampling & physical tests of malt.	1
10	Determination of moisture content of malt.	1
11	Determination of extract content of malt.	1
12	Determination of ethanol content of spirit sample by oxidation method.	1
13	Determination of fermentation efficiency of yeast growing on molasses medium.	1
14	Determination of total & fixed volatile acidity of rectified spirit (ISI method)	1
15	Determination of volatile acidity of rectified spirit (IS Imethod)	1
16	Determination of aldehyde content of Rectified Spirit (AOACMethod)	1
17	Determination of ester content of Rectified Spirit (AOACMethod)	1
18	Determination of fusel oil content in spirit sample.	1
19	Determination of furfural content in spirit sample.	1
20	To conduct potassium permanganate test for finding the quality of spirit.	1
21	Determination of fermentation efficiency of yeast growing on molasses medium.	1
22	Preparation of wine from grapes.	4
23	Determination of total reducing sugar of wine production.	1
24	Determination of pH & total acidity of wine.	1
25	Determination of Volatile acidity of wine	1
26	Determination of free & total Sulphur dioxide of wine	2
27	Determination of moisture and ash content of molasses.	1
28	Determination of total solids and suspended solids of molasses.	2
29	Determination of ethanol content of spirit by specific gravity method.	1

WT 2.5 Chemical and Plant Engineering-I

Summary

Credit No.	Credit title	Total hours per credit
2.51	Basic of Distillation	10
2.52	Basic of Instrumentation and pressure, flow & temperature measurement	20
total		30

Detail syllabus

Units	Topics	No. of Lectures
2.51	**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
2.52	**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. **Pressure measurement:** Various pressure units and their conversion, pressure transducers such as barometer, manometers, Bourdon tube, diaphragm, bellows, capsule, strain gauges. **Flow measurement:** Basic terms such as total flow, volumetric flow, Mass flow, types of flow, flow transducers such as orifice plate, flow nozzle venturi meter,rotameter, magnetic flowmeter, coriolis mass flow meter, displacement flowmeter. **Temperature measurement:** Various scales and conversion, Introduction to filled system thermometers, expansion thermometers, thermocouples, Resistance temperature detector, Thermistors. **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. Analytical Instrumentation: Refractometer, pH and conductivity meters, Spectrophotometer, Alcometers.	20

Reference Books:

1. Mass Transfer Operations – Robert E. Treybal
2. Introduction to Chemical Engineering – Ghosal&Sanyal
3. Unit Operations of Chemical Engineering – Warren L. McCabbe, Julian C. Smith
4. Process Heat Transfer- D. Q. Kern
5. Instrument Engineers handbook – Process measurement by BG Liptak
6. Process Instrumentation & Control by A. P. Kulkarni
7. Process Control Instrumentation Technology by C. D. Johnson.
8. Instrumental methods of analysis by Willard, Merrit & Dean.

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

Sr. No.	Title of practical	No. of practical
1	Measurement of 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 OR RTD based temperature indicator	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	To study the ΔP across the filter aid. **OR** 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 discharge coefficient 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 discharge coefficient using Venturi meter	1
11	Calibration of conductivity meter	1
12	To study Rayleigh equation and study simple distillation.	1
13	To study characteristics of steam distillation.	1
14	To calibrate pressure gauge and vacuum gauge using dead weight tester and plot its output response curve	2

Semester III

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

Semester IV

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

Semester III
WT 3.1-Alcohol Technology-II

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

Details of syllabus

Unit	
3.11	**Characteristics of various alcohols, denaturation and by-products of alcohol** Composition of Wash, RS, EQRS, ENA, EQENA, FA, AA and IS. Denaturation of spirit – Denaturating agents O.D.S, S.D.S., ware house practices – Excise Rules & Regulations. Distillation – Atmospheric distillation process and its operation & maintenance, Specifications of plant and machinery. By products of alcohol manufacture – CO_2, fusel oil & yeast sludge.\
3.12	**Manufacture of Extra Neutral Alcohol, Anhydrous alcohol/Fuel ethanol** Process details, utilities requirement, specifications of ENA, quality aspect, specifications of plant and machinery. Azeotropic mixture commercial production of ethanol by azeotropic distillation. Distillation efficiency, Effect of traces of entrainer (benzene, cyclohexane, monoethylene glycol) on fuel ethanol. Rules with examples, Maturation and Aging of spirit: Factors influencing alcoholic fermentation.
3.13	**Reduction, blending and alcoholic beverages; Making of various traditional beverages** Alcoholic beverages-Classification of beverages, liquor, country liquor manufacturing process. Quality control aspects. Global practices for manufacturing of IMFL. Maturation and aging: changes during maturation (spirit characters, aroma, flavor etc). Types of wood used for cask/barrel making. Typical design of barrel, Role of excise department in alcoholic beverages industry. Shelf life of alcoholic beverages. Introduction to making of grain based popular beverages in the world. Indian rice beer (Pachwai), Bhaati Jaanr, Chhang (Lugri, Jhol, Chakti, Ghanti), Themsing, Rakshi, Mingri, Lohpani, Bhangchang, Apong, Sekete, Mhauwa liquor etc.

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

Reference Book:

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

WT 3.2 Brewing technology-II

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

Details of syllabus

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

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

Reference Book:

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

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

WT 3.3 Enology- II

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

Details of syllabus

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

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

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

WT 3.4 Practical (Conduct any 30 practical's)

Sr. No.	Title of practical	No. of practical
1	Determination of residue on evaporation of whisky sample.	1
2	Determination of ethyl alcohol content of whisky by specific gravity method	1
3	To determine the volatile acidity whisky sample.	1
4	Determination of Methyl Alcohol (as CH_3OH) content of whisky	1
5	Determination of alcohol content of brandy by densitometer OR hydrometer	1
6	Determination of alcohol content of whisky by densitometer OR hydrometer	1
7	Determination of alcohol content of spirit by densitometer OR hydrometer	1
8	Reduction of the spirit	1
9	Blending of spirit	1
10	Propagation of yeast in laboratory (Demonstration experiment)	1
11	Determination of starch content in grain flour sample.	1
12	Estimation of hop bitterness and colour of beer	1
13	Determination of total plate count of wine	1
14	Detection of microbial contamination in beer	2
15	Quality control aspects of cap, label and bottles of IMFL (2 Practical's)	1
16	Sensory evaluation of wine samples	3
17	Alcohol production from corn/sorghum/sweet potato/molasses	3
18	Brandy production from wine	2
19	Alcohol estimation in wine	1
20	Determination of reducing sugar of wine by Lane and Eynon method	1
21	Making of wine from other than grapes	2
22	Isolation of lactic acid bacteria from wine	1
23	Isolation of wild yeast from wine	1
24	Isolation of acetic acid bacteria from wine	1

3.5 WT Marketing of alcoholic beverages

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

Details of syllabus

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

Reference books:

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

M. Sc.-Part-II **M. Sc. (Wine, Brewing & Alcohol Technology)**

WT 3.6 Practical Course-II (conduct any 15 practical's)

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

Semester-IV

WT 4.1. Industrial Waste Treatment & Environmental Management

Summary

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

Details of syllabus

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

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

Reference Books:

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

WT 4.2. Business Management: (BM)

Summary

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

Details of syllabus

Units	Topics	No. of lectures
4.21	**Business Management and Communication in Wine, Brewing & Alcohol Industry:** i. Principles of Management ii. Business Communication and soft skills iii. Financial Accounting iv. Economic Environment of Business preneurship Development	15
4.22	**Operations Management:** i. **Process Management**:Explores how to Organize for production e.g. the design and development of products, forecasting demand, planning capacity Plant location and layout, production systems, process design and technology ii. **Production Management**The people factor in production. Management: personnel, costs, investment and automatization **iii. Integral Quality/Assurance and ISO 9000** 1. Microbiology control 2. Physicochemical analysis of raw material, intermediate and final product Hygiene, cleaning, disinfection, and pasteurization. 3. Wastewater treatment Off-plant beer treatment: transport, storage and serving of beer. iv. **Product development**: low alcohol beers, diet beers (light beers) etc	**15**

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

Reference books:

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

M. Sc.-Part-II **M. Sc. (Wine, Brewing & Alcohol Technology)**

WT 4.3 Chemical & Plant engineering –II

Summary

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

Details of syllabus

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

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

Reference Books:

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

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

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

WT 4.5.1 Alcohol Technology-III

Summary

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

Details of syllabus

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

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

Reference Book:

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

WT 4.5.2 Practical (Conduct any 15 practical's)

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

WT 4.6.1 Brewing Technology-III

Summary

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

Details of syllabus

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

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

Reference Book:

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

WT 4.6.2 Practical (Conduct any 15 practical's)

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

WT 4.7.1 Enology-III

Summary

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

Details of syllabus

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

	harsh and drying tannins, deacidification, acidification, dealing with stuck fermentation

Referance Book-

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

WT 4.7.2 –Practical (Conduct any 15 practical's)

1. Determination of methanol content of wine.
2. Pre operations of wine bottling –Details of quality measures
3. Demonstration of filtration of wine
4. Demonstration of bottling of wine
5. Assess and conduct fining trails of bentonite on wine.
6. Assess and conduct fining trails of PVPP on wine.
7. Assess and conduct fining trails of Gelatin on wine.
8. Assess and conduct fining trails of egg albumen/egg white on wine.
9. Conduct heat stability test for protein stability in wine(2 practical's)
10. Conduct cold stability test for tartrate stability in wine(2 practical's)
11. Detect iron haze & copper haze in given wine sample
12. Determine SO_2 of given wine by aspiration method.
13. Perform oxidative test for red wine.
14. Determine microbiological stability test of given wine sample
15. Determine carbon dioxide content of given wine sample
16. Quality control aspects of packaging materials of wine bottles
17. Perform matching wine with food
18. Assess and conduct blending trail of wine.
19. New techniques in wine production world: A case study