

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

Course Structure 2010-11

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

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

M. Sc. Part – I
Semester-I

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

Semester-II

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

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

Semester-III

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

Semester-IV

WT 4.1 Business Management

WT 4.2 Industrial waste treatment & Environmental management

WT 4.3 Alcohol Technology-III

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

WT 4.41 CHEM-CAD design (CCD)

WT 4.42 Advance Brewing Technology

WT 4.43 Advance Enology

WT 4.44 Second Generation Biofuels

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

M. Sc. - I Semester-I

WT 1.1 Viticulture

Section-I

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

Section-II

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

Reference Books:

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

WT 1.2 Microbiology of Alcohol, Beer and Wine

Section-I

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

Section-II

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

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

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

Reference Books:

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

WT 1.3 Biochemistry of Alcohol, Beer and Wine

Section-I

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

Section-II

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

Reference Books:

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

WT 1.4 Practical-I

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

WT 1.5 practical-II

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

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

Semester –II

WT 2.1 Alcohol Technology – I

Section-I

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

Section-II

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

Reference Books:

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

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

WT 2.2 Brewing Technology-I

Section-I

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

Section-II

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

Reference Book:

2. *American Society of Brewing Chemists, U.S.A.: Methods of analysis of American society of brewing chemists. (8th rev.) U.S.A. American society of brewing chemists, 1996. 1-881696-01-4-(AME)*
3. *Arntzen, C.J., ed.: Encyclopedia of agricultural science, vol. 1: - A - D. N. York, Academic Press, 1994. Rs.18802.00-- (630.3 ARNARN)*
4. *Birch, G.G.: Alcoholic beverages. London, Elsevier Applied Science Pub.1985., Rs.369.20-- (663.1BIR)*
5. *Government of India. Technical Excise Manual. --(663.16GOV)*
6. *Hardwick, W.A., ed.: Handbook of brewing. N.York, Marcel Dekker, Inc., 1995., Rs.6181.50--(663.3 HARHAR)*
7. *Hough, J.S., Briggs, D.E., Stevens, R., Young, T.W.: Malting & brewing science, vol. 2 : hopped wort & water. London, Chapman & Hall, 1982. Rs.591.50- (663.3HOU)*
8. *Pollock, J.R.A., and ed.: Brewing science vol. 1. London, Academic Press, 1979, Rs.7046.80-- (663.3POL)*
9. *Pollock, J.R.A., and ed.: Brewing science, vol. 2. London, Academic Press, 1981., Rs.7046.80-- (663.3POL)*
10. *Prescott, S.C. & Dunn, C.G.: Industrial microbiology. Jodhpur. Agrobios (India), 2002. 81-7754-149-8*
11. *Priest, F.G.: Brewing microbiology, 2nd ed.. (1996) U.K. Chapman & Hall, 1996. 0412591502--(576PRI)*
11. *Priest, Fergus G.; & Stewart, Graham G.: Handbook of brewing. (2nd) U.S.A. CRC Press, Taylor & Francis Group, 2006. 0-8247-2657 x*

WT 2.3 Enology-I.

Section-I

1. Introduction: History of wine making, present international and national status of wine production and wine market, scope and importance of wine industries, nutritional and therapeutic value of wine, commercial aspect of wine production.
2. Classification of wine- table wines, sparkling wine, dessert wines, aperitif wine, pop wine.
3. Wine making processes- Red wine production-time of harvest, harvesting, crushing & fermentation, blending; White wine production- White wine styles, harvesting, crushing, pressing, settling/clarification & fermentation.
4. Sparking wine- The Champagne method, the tank method, the transfer method, carbonation; cold maceration; carbonic maceration; thermo vinification; chaptalisation; use of commercial enzyme in wine making.
5. Monitoring and controlling of fermentation parameters of wine: monitoring and viability and cell number of yeast during must preparation, controlling microbial growth during wine production, effect of pH, temperature, CO₂, amount of sugar consumed.

Section-II

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

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

Reference Book:

1. *Handbook of Enology, Vol. I. The Microbiology of Wine and Vinification- P. Ribereau- Gayon, D. Dubourdieu, B. Doneche, A. Lonvaud.*
2. *American Society for Enology and Viticulture- Seattle.*
3. *Australian Society of Viticulture and Enology - Andrew Markides, Richard Gibson.*
4. *Introduction to winemaking, Viticulture and Enology 3- Prof. Ralph E. Kunkee.*
5. *Understanding wine- Course notes- Patrick Iland, Peter Gago.*
6. *Wine science- Ron S. Jackson.*
7. *Handbook of Enology, Vol 2- The chemistry of wine stabilization and treatments- P. Ribereau – Gayon, D. Dubourdieu, A. Maujean, Y. Glories.*
8. *Concepts on wine chemistry- the wine appreciation guide- Yair Margalit, James Crum.*
9. *Wine making from grape growing to marketplace- Richard P. Vine, Ellen M. Harkness, Salley J. Linton.*
10. *Monitoring the wine making process from grapes to win techniques and concepts- Patrick ILAND, Nick BRUER, Andrew EWART, Andrew MARKIDES, John SITTERS.*
11. *Wine appreciation- Richard P. Vine.*
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WT 2.4 Chemical and Plant Engineering-I

Section-I Chemical and Plant Engineering

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

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

Reference Books:

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

Section-II Instrumentation:

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

Reference Books:

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

WT 2.5 Practical- I:

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