

**SHIVAJI UNIVERSITY,  
KOLHAPUR**



**New Syllabus for  
Master of Science (Sugar Technology)  
Part-II (Semester-III and Semester -IV)  
Syllabus to be approved from  
June 2021 onwards**

**M.Sc. Sugar Technology Part-II (Sem:III)**

	Course	Paper			Title of course
CGPA	CC-301	IX	ST.3.1	Compulsory Course	Equipment's & capacity calculation
	CC-302	X	ST.3.2	Compulsory Course	Allied sugar manufacturing.
	CC-303	XI	ST.3.3	Compulsory Course	Chemical engineering heat and material transfer
	CC-304	XII	ST.3.4	Choose any one	Alcohol Technology
			ST.3.4	Choose any one	Bio chemical Engineering
			ST.3.4	Choose any one	Electronics and Instrument Engineering
	CCPR-305		STP.3	Compulsory Course	Sugartechnology Practical III
Non-	AEC -306				

**M.Sc. Sugar Technology Part-II (Sem:IV)**

	Course	Paper			Title of course
CGPA	CC-301	XIII	ST.4.1	Compulsory Course	Allied Co Product Manufacturing
	CC-302	XIV	ST.4.2	Compulsory Course	Advance sugar technology and engineering
	CC-303	XV	ST.4.3	Compulsory Course	Chemical Engineering
	CC-304	XVI	ST.4.4	Choose any one	Energy Conversion and Co-generation
			ST.4.4	Choose any one	Pollution Prevention and Control
			ST.4.4	Choose any one	Water Management and Zero discharge
	CCPR-305		STP.4	Compulsory Course	Sugar Technology IV
Non-	AEC -306				

**Paper: IX (ECC)- Equipment's & capacity calculation**

Unit	Syllabus	Lectures
I	<p>a) Capacity of weighing scale and reaction tank.</p> <ul style="list-style-type: none"> <li>• Capacity of juice and imbibition's water weighing scale,</li> <li>• Capacity of raw juice and imbibition's water pumps,</li> <li>• Capacity of reaction tank, calculation of retention time of juice in reaction tank. Calculation for SO<sub>2</sub> gas distribution system</li> </ul> <p>b) Capacity of equipment for process chemical</p> <ul style="list-style-type: none"> <li>• Capacity of phosphoric acid tank and dosing equipment.</li> <li>• Capacity of lime preparation equipment's and lime pumps.</li> <li>• Capacity of sulphur burner and air compressor.</li> </ul>	15
II	<p>a) Capacity of juice heater</p> <ul style="list-style-type: none"> <li>• Calculation of juice heater capacity.(HS)</li> <li>• Calculation of juice velocity in the juice heater.</li> <li>• Calculation of number tubes and passes in the juice heater.</li> <li>• Calculation of juice inlet/outlet pipe</li> <li>• Calculation of steam/vapor pipe size</li> <li>• Calculation of condensate pipe size,</li> <li>• calculation of non-condensable gases pipe size</li> <li>• Calculation of tube plate diameter.</li> </ul> <p>b) Capacity of clarifier &amp; vacuum filter</p> <ul style="list-style-type: none"> <li>• Juice retention time in different type of clarifier</li> <li>• Capacity of clarifier</li> <li>• Capacity of clear juice pump, capacity of mud pump. Capacity of flash tank.</li> <li>• Capacity of rotary vacuum filter.</li> <li>• Capacity of syrup sulphitor and syrup pumps</li> </ul>	15
III	<p>a) Capacity of evaporator</p> <ul style="list-style-type: none"> <li>• Co-efficient of heat transmission,</li> <li>• Quantity of water evaporated,</li> <li>• Heating surface of evaporator station.</li> <li>• Calculation of individual Brix</li> <li>• Calculation of vapor piping</li> <li>• Steam requirement without vapor bleeding, steam requirement</li> </ul>	15

	<p>with vapor bleeding to juice heater and pan.</p> <p><b>b) Vacuum pan</b></p> <ul style="list-style-type: none"> <li>• Pan capacity by massecuite % cane method.</li> <li>• Calculation of heating surface and number of tubes.</li> <li>• Pan capacity by solid balance method.</li> <li>• Calculation of vapor pipe &amp; condensate pipe size.</li> <li>• Sizing of condenser , water requirement for condenser, capacity of injection pump.</li> </ul>	
IV	<p><b>a) Centrifugals</b></p> <ul style="list-style-type: none"> <li>• Capacity of cooling crystallizers, quantity of water required for cooling,</li> <li>• Capacity of centrifugal, capacity of runoff pump.</li> <li>• Capacity of melter and melt pump</li> <li>• Capacity of final molasses weighing scale.</li> <li>• Capacity of superheated wash water system.</li> </ul> <p><b>b) Finishing operation.</b></p> <ul style="list-style-type: none"> <li>• Capacity of hopper, elevator and grader.</li> <li>• Capacity of hot and cold air blower.</li> <li>• Capacity of sugar silo.</li> <li>• Capacity of molasses storage tank,</li> <li>• Capacity of sugar storage godown</li> </ul>	15

**Reference Books:**

1. Hand book of cane sugar, E. Hugot
2. Cane sugar engineering, Peter Rain.
3. Machinery & equipments of sugar factory, L. A. Tromp
4. Cane sugar hand book, R. B. L. Mathur
5. Modern milling of sugar cane, Maxwell
6. Standard fabrication practices of cane sugar mill, Delden.
7. cane sugar manufacturing in India, D. P. Kulkarn

**Paper – X (ASM) Allied sugar manufacturing.**

<b>Unit</b>	<b>Syllabus</b>	<b>Lectures</b>
I	Manufacturing of raw sugar: <ul style="list-style-type: none"><li>• Clarification process</li><li>• Crystallization process</li><li>• Centrifugal process</li></ul>	15
II	Manufacturing of refine sugar <ul style="list-style-type: none"><li>• Types of refineries</li><li>• Mingling and affination process.</li><li>• Clarification of refine melt</li><li>• Evaporation &amp; crystallization process</li><li>• Drying, cooling and blending system.</li><li>• Specification of refine sugar</li></ul>	15
III	Manufacturing of Khandsari sugar <ul style="list-style-type: none"><li>• Specification of Khandsari sugar.</li><li>• Extraction &amp; clarification of cane juice.</li><li>• Open pan boiling system</li><li>• Purging drying &amp; packing system</li></ul>	12
IV	Manufacturing of Jaggery & Jaggery powder. <ul style="list-style-type: none"><li>• Extraction &amp; clarification of juice</li><li>• Concentration of juice to rab</li><li>• Drying &amp; packing of Jaggery.</li><li>• Crystallization process of Jaggery powder.</li><li>• Curing, drying and packing of Jaggery powder</li></ul>	12
V	Manufacturing of branded sugar <ul style="list-style-type: none"><li>• Production of candy sugar</li><li>• Production of brown sugar</li><li>• Production liquid sugar</li></ul>	06

**Reference books:**

1. Hand book of sugar refinery, Chung Chi Chou
2. Manufacture & refining of raw sugar, V. E. Baikow

**M.Sc. -Sugar technology Part II (Semester -III )**  
**Paper – XI (CEHMT) Chemical engineering heat and material transfer**

Unit	Syllabus	Lectures
I	Heat transfer <ul style="list-style-type: none"> <li>• Conduction- Mechanism of heat transfer by conduction in solids, Fourier's law of heat transfer, Thermal conductivity, and heat loss in conduction. Thermal insulation and optimum thickness for insulation.</li> <li>• Convection- Heat transfer by convection, forced and natural convection, individual and overall heat transfer coefficient. Fouling factor, overall resistance. Effect of drop wise and film wise condensation, Effect of non-condensable gases.</li> <li>• Radiation -heat transfer by radiation. Kirchhoff's law, Stefan-Boltzmann law</li> </ul>	15
II	Heat transfer equipment's <ul style="list-style-type: none"> <li>• Heater- multipass shell and tube type heat exchanger-shell, tubes, tube pitch ligaments' (clearance), tube passes, Baffles.</li> <li>• Condenser-types of condenser co-current &amp; counter current.</li> <li>• Derivation of overall heat transfer coefficient from hot fluid to cold fluid through metal wall</li> </ul>	15
III	Fluid transfer <ul style="list-style-type: none"> <li>• Fluid statics- Concept of momentum transfer, Nature of fluid and pressure concept, variation of pressure with height- hydrostatic equilibrium. Barometric equation, measurement of fluid pressure manometer.</li> <li>• Fluid flow –types of fluid's , viscosity of gases and liquids. Types of flow – laminar &amp; turbulent, Reynolds number. Basic equation of fluid flow, Average velocity, and mass velocity, conductivity equation, flow of incompressible fluids. Laminar flow through circular circuit, turbulent flow through pipes, friction factor</li> </ul>	15
IV	Fluid transfer equipment's <ul style="list-style-type: none"> <li>• Pumps – positive displacement and centrifugal pumps. Fans, compressor and blower. Metering of fluids - Pipes, Fitting and valves, measurement of liquid and gas flow rates by orifice meter, venture meter, rot meter and Pilot tube.</li> </ul>	15

**Reference books:**

1. Unit operations & Unit Processes, C. M. Narayanan, B. C. Bhattacharya.
2. Unit operations I & II (Heat & Mass Transfer), K. A. Gavhane
3. Chemical Engineering (Heat Transfer & fluid flow), J. M. Coulson
4. Unit operations & chemical engineering, P. Chattopadhyay

**M.Sc. -Sugar technology Part II (Semester -III )**  
**Paper – XII (ET) AT-Alcohol Technology( Elective 1)**

Unit	Syllabus	Lectures
I	a)Cane molasses <ul style="list-style-type: none"> <li>• Composition of molasses</li> <li>• gradation of molasses</li> <li>• storage of molasses</li> <li>• factors responsible for reducing the ratio (F/NF) of molasses</li> <li>• other use of molasses.</li> </ul> b)Definition of- <ul style="list-style-type: none"> <li>• Molasses, Total reducing sugar,</li> <li>• Fermentable/Unfermentable sugar, Residual sugar.</li> <li>• Wort, Brix, Specific gravity, Distillation, Industrial alcohol, Proof sprit, Strength of sprit, Reflux, Vaporization.</li> <li>• Saccharification,Scaling, Scrubber, Starch -sucrose, Rectification, Gelatinization,</li> <li>• liquefaction, Reboiler</li> </ul> c) Applied microbiology. <ul style="list-style-type: none"> <li>• Definition of yeast, Taxonomy of yeast</li> <li>• Morphology of yeast, type of microorganism.</li> <li>• Common strain of yeast used for alcoholic fermentation.</li> <li>• Growth requirement of yeast.</li> <li>• Yeast structure &amp; function of cellular components.</li> <li>• Metabolic pathway of yeast</li> <li>• Alcoholic pathway Glycolysis of EMP pathway</li> </ul>	15
II	a) Defination & type of fermentor <ul style="list-style-type: none"> <li>• Traditional batch, fed batch &amp; continuous fermentation</li> <li>• Difference between batch &amp; continuous fermentation.</li> <li>• Alcohol production from sweet sorghum</li> <li>• Alcohol production from cane syrup</li> </ul> b) Propagation of pure yeast culture. <ul style="list-style-type: none"> <li>• Isolation of yeast, preservation of yeast cell.</li> <li>• Preservation of pure culture on agar salt.</li> <li>• Preparation of slant, purpose of propagation.</li> <li>• Fundamental of yeast growth (Aerobic &amp; Anaerobic)</li> <li>• Crab tree effect.</li> <li>• Growth kinetics, significance of growth curve, lag phase, log phase, stationary phase, death phase etc.</li> <li>• Propagation stages &amp; aspartic condition</li> </ul>	15

III	<p>a)Types of distillation process.</p> <ul style="list-style-type: none"> <li>• Atmospheric distillation</li> <li>• MPR distillation</li> <li>• MPR benefits of vacuum distillation, RS, ENA production.</li> <li>• Production of anhydrous alcohol.</li> <li>• Dehydration with molecular sieve process &amp; membrane process.</li> </ul> <p>b) Distillation equipments</p> <ul style="list-style-type: none"> <li>• Columns, its design &amp; construction, its maintenance.</li> <li>• Types of trays</li> <li>• Types of condenser.</li> <li>• Types of reboiles</li> </ul>	15
IV	<p>a)Effluent treatment system in Distillery,</p> <ul style="list-style-type: none"> <li>• Quality of effluent, IS specification of effluent.</li> <li>• Biological treatments.</li> <li>• Aerobic treatments,</li> <li>• Anaerobic treatments</li> </ul> <p>b) Manufacturing of Methane gas &amp; composting.</p> <ul style="list-style-type: none"> <li>• Raw material requirement of biogas plant.</li> <li>• Design &amp; capacity of biogas plant</li> <li>• Moisture free methane generation.</li> <li>• Types of composting &amp; their production</li> <li>• Factors affecting composting process.</li> <li>• Economics consideration in composting process.</li> </ul>	15

**Reference books:**

1. Hand book of alcohol technology, S. V. Patil
2. Industrial alcohol technology hand book, NPCS Board of consultant & engineer



**M.Sc. -Sugar technology Part II (Semester -III )**  
**Paper – XII (ET) BCE-Bio-chemical engineering (Elective 2)**

Unit	Syllabus	Lectures
I	<p><b>Introduction:</b></p> <ul style="list-style-type: none"> <li>• Bioprocess engineering and technology. An introduction to basic biological science</li> <li>• Microbiology: Structure of cells: Prokaryotes &amp; Eukaryotes. Classification of microorganism. Taxonomy, control of microorganism– physical &amp; chemical methods.</li> <li>• Biological functions of lipids, sugars, polysaccharides, amino acids, vitamins, biopolymers, Nucleic acids: RNA, DNA and their derivatives</li> </ul>	15
II	<p><b>Enzymes and proteins:</b></p> <ul style="list-style-type: none"> <li>• Detailed structure of protein and enzymes. Functions. Methods of production and purification of enzymes. Nomenclature and classification of enzymes. Kinetics &amp; mechanism of enzymes action.</li> <li>• Kinetics of enzyme action: reversible enzyme, two substrate, multi-complexes enzyme kinetics. Experimental determination of rate parameters: Batch &amp; continuous flow experiments, Batch Kinetics.</li> <li>• Enzymes Inhibition: effect of inhibitors, temperature &amp; pH on the rates enzyme catalyzed reactions. Determination of kinetic parameters for various types of inhibitions. Dixon method. Enzyme immobilization: Uses, methods of immobilization .</li> </ul>	15
III	<p><b>Fermentation Technology</b></p> <ul style="list-style-type: none"> <li>• Ideal reactors: A review of batch and continuous flow reactors for bio kinetic measurements. Microbiological reactors: operation &amp; maintenance of typical aseptic aerobic fermentation processes.</li> <li>• Formulation of medium source and nutrients. Introduction to sterilization of bioprocess equipment.</li> <li>• Growth kinetics of microorganism: Transient growth kinetics (different phase of batch cultivation). Quantification of growth kinetic, continuous culture, optimum dilution rate and washout condition in ideal chemostat. Introduction to fed batch reactors</li> </ul>	15
IV	<p><b>Downstream processing:</b></p> <ul style="list-style-type: none"> <li>• Strategies and steps involved in product purification.</li> <li>• Methods of cell disruption, filtration, centrifugation sedimentation</li> <li>• Types of chromatography technique</li> </ul>	15

- |  |  |  |
|--|--|--|
|  | <ul style="list-style-type: none"><li>• Freeze drying lyophilisation &amp; membrane separation processes</li></ul> |  |
|--|--|--|

**Reference books:**

- 1) "Basic Principles and Calculations In Chemical Engineering" by HIMMELBLAU
- 2) "Principles of Mass Transfer and Separation Processes" by Dutta B K

**M.Sc. -Sugar technology Part II (Semester -III )**  
**Paper – XII (ET) EIC –Electronics and instrument engineering.(Elective 3)**

Unit	Syllabus	Lectures
I	<ul style="list-style-type: none"> <li>• Basic Electronics: Circuit elements in series &amp; parallel. Semiconductor Devices – Diode as Rectifier, Zener Diode as Voltage Regulator, Transistor as Amplifier. Field Effect Transistor –Jfet &amp; Mosfet. Thyristor – Silicon Controlled Rectifier.</li> <li>• Number Systems: Decimal &amp; binary systems, binary addition, subtraction, multiplication, division, use of complement.</li> <li>• Boolean Algebra: Basic laws of Boolean algebra, De-Morgan’s theorems, minimization techniques.</li> <li>• Logic Gates: OR, AND, NOT, NOR, NAND, EXOR gates.</li> <li>• Arithmetic Logic Units: Half adder, full adder, parallel binary adder and subtractor. Introduction to basic configuration of computer</li> </ul>	15
II	<ul style="list-style-type: none"> <li>• Instrumentation: Introduction, important terms associated with instruments such as range, span, accuracy, error and sensitivity.</li> <li>• Flow measurement: Types of flow, flow transducers - orifice plate, pitot tube, venturimeter. Description of rotameter, magnetic flow meter, ultrasonic flow meter etc.</li> <li>• Temperature measurement- Introduction to filled system thermometers, Expansion thermometers, thermocouples, RTD’s, Thermostats and pyrometers</li> </ul>	15
III	<ul style="list-style-type: none"> <li>• □Pressure measurement - Various units and their conversion, manometers, Bourdon tube, diaphragm, bellows, capsule, strain gauges for pressure measurement.</li> <li>• Level measurement: Direct methods - float methods, magnetic level indicator, magnetic level switches, indirect method - hydrostatic method, radiation method, ultrasonic method and capacitance method.</li> <li>• pH and conductivity measurement: Introduction, different types of sensors, pH meter and conductivity meter.</li> </ul>	15
IV	<ul style="list-style-type: none"> <li>• .Control System: Closed Loop System - Basic components. Servo and regulator control. Controllers – P, I, D and On –Off modes. Controller combinations - Final control elements -Valves, actuators and valve positioners.</li> <li>• PLC system, DCS system, SCADA sy</li> </ul>	15

**Reference Book:**

- 1) Hand book of sugar engineering By- H. Eugot
- 2) Industrial automation –process control & instrumentation- By S. Medida
- 3) The complete book on sugar cane processing –chapter 24 By H-panda
- 4) Instrumentation & automation in sugar industries By - S. S. Engineering.
- 5) Instrumentation – Shivaji university By Anand M.S.

## **Syllabus of Practical Courses - M. Sc. Sugar Technology (Semester-III)**

### **1. Sugar technology-III (Analysis of sugar as per ICUMSA Method):**

1. The Determination of sugar solution colour at pH 7.0 by the MOPS Method –Official Method GS 9/1/2/3 – 8 (2005), ICUMSA Method Book.
2. The determination of white sugar solution colour at pH 7.0 method GS 2/3 – 9 (2002)– ICUMSA Method Book.
3. The determination of white sugar solution colour - Official Method GS 2/3 – 10(2002), ICUMSA Method Book.
4. The determination of white sugar solution colour - Official, Method GS 2/3 – 10 (2003), ICUMSA Method Book.
5. The determination of Conductivity ash in sugar, method GS 2/3 – 17(2002) –ICUMSA Method Book.
6. The determination of moisture in sugar method GS 2/1/3–15(2002) – ICUMSA Method Book.
7. The determination of reducing sugar in sugar method GS 2/3/9 – 5(2007) ICUMSA Method Book.
8. The Determination of Insoluble Matter in White Sugar by Membrane Filtration Method GS

### **2. Sugar technology-IV (Analysis of process chemicals)**

1. Analysis of sulphur
  - a) Moisture % sulphur
  - b) Ash % sulphur
- a) Purity of sulphur
2. Determination of Cao & grit % in given sample of lime by sucrose method.
3. Determination of density & phosphate content in phosphoric acid.
4. Determination of SO<sub>2</sub> in hydrogen peroxide.
5. Mill sanitation –
  - a) Dithio-Carbamate base
  - b) Quaternary ammonium compound.
6. Determine total alkalinity of caustic soda.
7. Determine total acidity of HCl (Hydrochloric Acid)
8. Determine available chlorine & moisture content in bleaching powder.
9. Determine total fatty material & specific gravity in T.R.O. (Turkey Red Oil)
10. Determine total alkalinity in washing soda (Na<sub>2</sub>CO<sub>3</sub>).
11. Determine formaldehyde (formaline) content sodium sulphide meth

### **Reference books:**

- 1) Hand book of sugar engineering By-H.Eugot
- 2) Hand book of cane sugar By-R.B.L.Mathur
- 3) Cane sugar engineering By-Peter Rei
- 4) Machinery and equipments of cane sugar factory- By Tromp

**M.Sc. -Sugar technology Part II (Semester -IV )**  
**Paper – XIII (ACM) Allied Co Product Manufacturing**

Unit	Syllabus	Lectures
I	<p>Molasses</p> <ul style="list-style-type: none"> <li>• Composition of molasses, storage of molasses, Quality of molasses –pre clarification of molasses, Molasses for production of alcohol process, Molasses for production of yeast process, Molasses for production of acetone process, Molasses for production of glycerin process, Molasses for production of cattle feed process, other use of molasses in different countries</li> </ul>	18
II	<p>Bagasse</p> <ul style="list-style-type: none"> <li>• Composition of bagasse, storage of bagasse, Separation of pith from bagasse, Production of pulp and paper from bagasse process, Production of particle board and fiber board from bagasse process, Production of corrugated boards and boxes from bagasse process, Production of furfural from bagasse process, Production of xylitol from bagasse process, Production of plastic from lignin in bagasse process, Production of methane &amp; product gas from bagasse process, Production of cattle feed from bagasse process, Other use of bagasse and bagasse ash, Generation of surplus power from bagasse</li> </ul>	18
III	<p>Press mud (filter cake)</p> <ul style="list-style-type: none"> <li>• Composition of filter cake, Use of filter cake as fertilizer process, Use of filter cake for production of cane wax process, Use of filter cake for production of bio-gas process, Use of filter cake as fuel process, Use of filter cake as cattle feed process</li> </ul>	12
IV	<p>Ethanol production</p> <ul style="list-style-type: none"> <li>• Production of ethanol from cane juice and cane syrup –extraction of juice process .clarification of juice process .evaporation process, fermentation process. Distillation process and dehydration process.</li> </ul>	12

**Reference Books:**

- 1) Ethanol & distillation by H.C. Barron
- 2) The book on sugarcane processing & by-products of molasses – H. Panda.
- 3) Process synthesis for fuel ethanol production - C.A. Cardona.
- 4) Kale U.M
- 5) (1990) glance at distillery by-products DSTA 40<sup>th</sup> convention.

**M.Sc. -Sugar technology Part II (Semester -IV )**  
**Paper – XIV (ASTE) Advance sugar technology and engineering**

Unit	Syllabus	Lectures
I	<ul style="list-style-type: none"> <li>• screening of the juice Effect of bagasillo on manufacturing process, its removal by DSM screen, rotary screen &amp; two stage rotary screens, Advantage of rotary Screen</li> <li>• Juice stabilization &amp; pH control system On line mass flow meter for juice weighment, Auto pH control system for juice clarification,</li> <li>• New trends in clarification New trend in juice clarification- filtrate and syrup clarification, Advantages of above both processes</li> <li>• S.R.T Tray less clarifier or short retention time (S.R.T.) Clarifier, construction and working</li> <li>• Decanter Muddy juice treatments, construction and working</li> <li>• Sulphur Burner Film type sulphur burner, Instrumentation and automation for film type sulphur burner.</li> </ul>	15
II	<ul style="list-style-type: none"> <li>• Steam Economy Vapor bleeding and steam economy, Basic requirement of steam, Steam requirement when vapor are used for entire juice heating, Steam requirement when vapor are used for juice heating and pan boiling, On line conductivity measurement of condensate water, Flashing of condensate, Different steam saving device used in sugar industries</li> <li>• Pan Automation Pan boiling instrumentation and automation system for batch and continuous pan, Automatic Brix and temperature measurement of molasses conditioner, Automatic Brix and temperature measurement of melter</li> <li>• Centrifugal control Auto feed control system for centrifugal, Wash water system for centrifugal,</li> </ul>	15
III	<ul style="list-style-type: none"> <li>• Mill Efficiency Various factors affecting milling capacity and efficiency</li> <li>• Mill control</li> </ul>	15

	<p>Auto cane feeding control system for uniform feed rate, Automatic imbibitions water flow and temperature control system, Central lubricant system</p> <ul style="list-style-type: none"> <li>• Pressure feeding system TRPE.GRPF.UFR</li> <li>• Two roller mill</li> </ul>	
IV	<ul style="list-style-type: none"> <li>• Cane diffuser Heat and mass balance in cane diffuser, construction and working of the diffuser, comparison of cane diffuser with mill</li> <li>• Co-generation of surplus power and its potential.</li> <li>• power saving device A.C.VFD drive Planetary gearbox</li> <li>• Heat recovery unit Flash recovery system, condensate heat recovery system, H.P heater for High pressure boiler, vapcon system, sulphur burner</li> <li>• Boiler water Treatment Boiler Feed Water Treatment Plant, chemical treatment system</li> </ul>	15

**Reference Books:**

- 1) Hand book of sugar engineering By-H.Eugot
- 2) Hand book of cane sugar By-R.B.L.Mathur
- 3) Cane sugar engineering By-Peter Rein\
- 4) Machinery and equipments of cane sugar factory- By Trom



**M.Sc. -Sugar technology Part II (Semester -IV )**

**Paper – XV (CEUP) Chemical engineering –Unit Operation.**

Unit	Syllabus	Lectures
I	<ul style="list-style-type: none"> <li>• Size reduction Necessity&amp; mechanisim, Rattling’s law, kick’s law, Bond’s law, method of operating crusher, Size reduction in sugar industries.</li> <li>• Screening Standard screens, capacity of screen &amp; efficiency, Ideal and actual screen, screen analysis, equipments for industrial screening, sieve test of sugar.</li> <li>• leaching &amp;extraction Leaching techniques, perforations through solids bed, stationary bed &amp; moving bed. Counter-current leaching, theory of diffusion. Theory of extraction of juice from cane</li> </ul>	15
II	<ul style="list-style-type: none"> <li>• Sedimentation Law of settling, Stokes law, Batch settling test, Design feature of continuous thickeners, Determination of thickeners area ,factors affecting the settlings rates, Different type of settling equipments. Equipments in sugar industries.</li> <li>• Mixing &amp; Agitation. Introduction, classification of mixing equipments and its application. Mixers for mixing the material. (Solid-solid &amp;solid-liquid)</li> </ul>	15
III	<ul style="list-style-type: none"> <li>• Filtration Theory, factors affecting filtration and remedies, filter aid and their use, equipment used in sugar factory (Rotary vacuum filter).</li> <li>• Centrifugation. Theory, different types of centrifugals machines –Batch &amp; continuous, their performance study.</li> <li>• Separation Cylone separation membrane separation, ultra filtration &amp;reverse osmosis</li> </ul>	15
IV	<ul style="list-style-type: none"> <li>• Evaporation Effects of liquid characteristics, Mechanism of heat transfer from condensing steam to boiling liquid, factors affecting heat transfer ,boiling point elevation, Daring’s rule, calculation of enthalpy balance for single and multiple effects evaporator</li> <li>• Crystallization.  Saturation, solubility and super solubility, nucleation and different nucleation system, Effects of impurities on crystal formation, Crystallization mechanism, crystal growth, agglomeration, breakages and crystal distributions.</li> </ul>	15

	<ul style="list-style-type: none"><li>• drying, cooling and conveying</li></ul> <p>General principle rate of drying ,diffusion &amp; capillary theory drying ,drying equipments. Need of cooling, cooling equipments in sugar industries. Types of conveyor, various conveyor used in sugar industries..</p>	
--	--	--

**Reference books:**

1. Unit operations & Unit Processes, C. M. Narayanan, B. C. Bhattacharya.
2. Unit operations I & II (Heat & Mass Transfer), K. A. Gavhane
3. Chemical Engineering (Heat Transfer & fluid flow), J. M. Coulsou
4. Unit operations & chemical engineering, P. Chattopadhyay

**M.Sc. -Sugar technology Part II (Semester -IV)**  
**Paper – XVI (ET) ECC-Energy Conversion and Co-generation (Elective 1)**

Unit	Syllabus	Lectures
I	<p><b>a) Elements of Electro Mechanical Energy Conversion</b> Introduction, Salient aspects of conversion ,Energy Balance ,Magnetic field system : Energy and Co energy ,A simple Electromechanical system, Energy in terms of Electrical Parameters, Rotary Motion, Dynamic Equation and system model of a simple system</p> <p><b>b) D.G. Generators</b>            Simple loop generator, Practical Generator ,Yoke,, pole cores and pole shoes, .pole coils Armature core Armature windings Commutator Brushes and Bearings Pole pitch ConductorTypes of Generators, Measurement of generator Efficiency charters tics of generator.</p>	15
II	<p><b>a) D. C. Motor</b>            Motor Principle, Comparison of Generator and Motor Action,, Significance of the Back e.m.f ,Voltage Equation of a Motor, Condition for Maximum Power ,Torque ,Armature Torque of Motor ,Shaft Torque ,Speed of D.C. Motor ,Speed Regulation Torque and speed of D.C. Motor ,Motor Characteristics, Characteristics of series Motors .Characteristics of Shunt Motors Compound Motors ,Performance Curves ,Comparison of Shunt Motor and Series Motor Power stages</p> <p><b>b) Speed Control of D.C. Motors</b>            Factors Controlling Motor Speed ,Speed Control of Shunt Motors , Flux Control Method ,Armature or Rheostat Control Method Voltage Control Method Speed Control or series method Flux Control Method Variable Resistance in series with motor Measurement of motor Efficiency</p>	15
III	<p><b>a) Transformer</b>            Working principle of a Transformer, Transformer Construction Core – type Transformers. Shell – type Transformers,, Elementary Theory of an ideal Transformer, D.M.F. equation of Transformer, Voltage Transformation Ratio (K) Transformer with losses but no magnetic Leakage ,Transformer on No- load Transformer on load</p>	15

	<p>,Transformer with winding resistance but no magnetic Leakage Magnetic Leakage Transformer with resistance and leakage reactance, Estimation of Transformer Efficiency (at Full Load &amp; Actual Load)</p> <p><b>b) Transformer Three phase</b> Three – Phase Transformer Connection, Star/star or Y/Y Connection ,Delta-delta connection ,Wye/delta –connection , Delta/wye connection</p>	
IV	<p><b>Induction Motor</b></p> <p>Classification of A.C. Motors, Induction Motor : General Principle &amp;Construction ,Squirrel- cage rotor ,Phase – wound rotor , Production of Rotating Field ,Three – Phase Supply ,Mathematical proof ,Why does the rotor rotate ? ,Slip ,Frequency of rotor current , Starting Torque of a squirrel – cage motor ,Starting Torque of a slip – ring motor Torque /Speed Curve , Current / speed curve of an induction motor</p> <p><b>Single – Phase Motor</b></p> <p>Types of single – phase motors ,single – phase induction motor , Double – field revolving Theory ,Making single – phase induction motor self – starting Types of capacitor – star motors ,Repulsion type motors , Repulsion motor , Repulsion Principle</p>	15

**Reference Book :**

1. Text book of “Electrical Technology” Vol. II , B.L. Theraja & A.K. Theraja , S. Chand Publication
2. “Electrical Machines ” by P.S. Bhimbra

**M.Sc. -Sugar technology Part II (Semester -IV)**  
**Paper – XVI (ET) PPC-Pollution Prevention and Control (Elective 2)**

Unit	Syllabus	Lectures
I	<ul style="list-style-type: none"> <li>• Importance of environments.</li> <li>• Biosphere and layers of atmosphere.</li> <li>• Hydrological &amp; nutrient cycles</li> <li>• Types of pollution, damages from environmental pollution.</li> <li>• Need of environmental legislations and environmental acts.</li> <li>• Function of state &amp; central pollution control boards.</li> </ul>	15
II	<ul style="list-style-type: none"> <li>• Source, classification and characterization of waste water.</li> <li>• Physical &amp; chemical characteristics' of waste.</li> <li>• BOD, COD and their importance</li> <li>• Types of water pollution and their effects.</li> <li>• Sampling and method of analysis.</li> </ul>	15
III	<ul style="list-style-type: none"> <li>• Preliminary, primary, secondary &amp; tertiary treatments of waste water.</li> <li>• Sludge treatments and disposal.</li> <li>• Advance waste water treatments.</li> <li>• Recovery of material from process effluents.</li> <li>• Application to industries.</li> <li>• Norms and slandered of treated water,</li> </ul>	15
IV	<ul style="list-style-type: none"> <li>• Air pollution-classification and source of air pollution. Air quality criteria and standards effects of air pollution on health vegetation and material, Air pollution control methods. Equipment used in industries.</li> <li>• Solid waste treatments-origin, classification and microbiology, properties and their variation. Engineering system for solid waste managements. Generation, Handling, storage collection, transport compositing and land filling.</li> <li>• Noise pollution-source and determination of level .noise control criteria and noice exposure indux.adminisretive and engineering control. Acoustic absorptive material.</li> </ul>	15

**M.Sc. -Sugar technology Part II (Semester -IV )**

**Paper – XVI (ET) WMZD-Water Management and Zero discharge (Elective 3)**

Unit	Syllabus	Lectures
I	<p>Water &amp; water treatments</p> <ul style="list-style-type: none"> <li>• Water properties &amp; nature, Source of water, Uses of water &amp; basic chemistry ,Water related table</li> <li>• Treatments- Filtration, Clarification, Oxidation, Chlorination, De-aeration</li> <li>• Ion-exchange method, Softener De-alkalization, Demineralization application &amp; limitation. Resin</li> <li>• Membrane technology Ultra filtration, Nano filtration, Reverse osmosis, Electro-dialysis</li> </ul>	15
II	<p>Boiler water treatments</p> <ul style="list-style-type: none"> <li>• Feed water treatment, Condensate treatment, Boiler water treatment.</li> <li>• Boiler blow down, Reasons of boiler failures, Boiler preventive maintenance. Tubes internal chemical cleaning</li> <li>• Boiler feed &amp; boiler water treatments, boiler water limits. Carryover &amp; priming in boiler.</li> </ul>	15
III	<p>Cooling tower &amp; cooling water treatments [15]</p> <ul style="list-style-type: none"> <li>• Cooling tower, Need of cooling tower, Classification of cooling tower. Cooling tower maintenance Cooling tower technical definition &amp;calculations</li> <li>• Treatment of cooling water (physical &amp; chemical), Problem in cooling water treatments</li> <li>• Analytical methods &amp; lab equipments Recommended analytical methods Recommended analytical equipments Composition of reagents</li> <li>• Expression &amp; interpretation of analytical result Analysis of raw water, clarifier water, filter water, soft water, ultra filtration of water, R. O. water, D. M. Water &amp; mixed bed water, Make up and recalculating life</li> </ul>	15

IV	<ul style="list-style-type: none"> <li>• Automation and instrumentation for safety working at Water treatment Effluent treatment In plant control method</li> <li>• Environment acts and guide line.</li> <li>• c) Air pollution; source &amp; control equipments</li> </ul>	15
----	--	----

**Reference Books:**

1. Efficient management in sugar industries, Mangal Singh
2. Geoeconomical study of waste water management of sugar industries, S. A. Manglekar
3. Ge betz hand book
4. Nalco water treatments
5. Albtros hand book

## **M. Sc., PART-II (SEMESTAR-IV)**

### **Sugar Technology (Practical's)**

#### **1. In Plant Training-I**

##### **Factory Practice (Internship/In-plant Training)**

##### **LABORATORY PRACTICE**

Determination of Brix, Pol & Purity of sugar house products, Special Analysis Experiments. Boiler Water and Effluent Analysis. Boiling House Stock taking, calculation of Recovery%, Preparation of DMR

#### **CANE DEPARTMENT**

Organization and working of the department, staffing pattern, duties of field man, cane supervisor etc., cane area of the factory, cane varieties and their acreage, number of registered farmers, sugarcane planting, crop monitoring, post-harvest maturity survey, Issue of cutting orders and harvesting procedures, managing harvesting labour and cane transport to factory, managing yard balance, measures to reduce cut to crush delay, varietal improvements, farmers education & training under taken.

#### **MILLING**

Cane weighing, cane unloading, operation of feeder table & cane carrier, technical information of preparatory devices and their drives, preparatory index achieved, automation of cane feeding, problems faced & maintenance. Cane conveying to mills, rake carriers, belt conveyors, donnelly chute & pressure feeders, inter carriers.

Working of the Mills – crushing rate, rpm of mills, hydraulic load etc., - roller grooving, pitch, Imbibition %, effect of imbibition on capacity and mill extraction, Mill setting Calculations, Brix Curves and its Significance, pumping of Juice, gutters, pumps & piping details – Mill Drives.

Juice Screening – working of rotary screen (Operation, Cleaning & Maintenance), weighing & metering of juice & water, scale. Problems in Milling and remedies (Operational and Mechanical) Importance of Mill Log Book – staffing pattern (Fitters, Helpers etc), Off - seasonal Maintenance.

#### **BOILER**

Technical details of boiler, fuel management, operation of boiler, water level control, maintaining boiler pressure, blowdown, furnace Cleaning – Feed water treatment, condensate management, Make



injection pump load checking, condenser spray & jet regulation, pan-evaporator vapor pressure stabilization, syrup load high, other operational problems like vacuum leakage, hammering, low pressure exhaust etc. Working of evaporator before and after cleaning. Heating surface, vapor pipe diameter of different bodies and other design parameters, instrumentation, pressure/vacuum/temperature of each body. Cleaning of evaporator, water test, vacuum test, Hydraulic test etc., off-season work.

#### **PAN :**

Boiling 'A' massecuite: Quantity of seed, washing and setting of grains, giving drinks, removal of dust, cutting the footing, boiling of massecuite. Managing the syrup, melt, AL load - Checking the brix of the massecuite for dropping, dropping the pan and re starting the pan.

Boiling of B & C massecuite: Graining, graining medium, slurry introduction, hardening, setting the grains, movement water, removal of false grains, boiling the strike massecuite.

Operational problems viz.,: Syrup and molasses load, low vapor pressure, vacuum trouble, want of crystalliser, high temperature boiling, etc., Monitoring the pan floor position, co-ordination between evaporator and panfloor, distribution of pans, capacity utilisation, steam/vapor management during starting and dropping of pans, vacuum crystalliser, seed crystallizer, automation at pans, off-season work.

Working of Spray pond/cooling tower, Injection water pumps, service pump, priming of pump, pump starting, off-season work

#### **CRYSTALLIZER & CENTRIFUGALS**

Working of crystallizer, batch/continuous/MVC, distribution of crystallisers, capacity, cooling/reheating, transient heater, air/water cooled crystallizer.

Centrifugals: Type and make, curing of A massecuite, operation of the A centrifugal, operational, mechanical and electrical troubles, curing cold viscous massecuite, operation of continuous centrifugals, controlling of problems. Off-season work.

Sugar Dryer: Working of dryer, drying & cooling, air requirement, conveying, grader, grading of sugar, weighing and bagging, stacking of sugar bags, godown procedures, sugar sales etc. Molasses weighing, Storage, cooling, sales and dispatch.

Effluent Treatment: methods of effluent treatment, norms of various constituents, zero discharge concept, water balance - calculation of water % cane.

#### **GENERAL**

Setting up of Sugar Factory, Organizational Structure, History of the factory, welfare activities, corporate social responsibility, functioning of engineering, manufacturing depts., duties and functions of the various section heads. Accounts Dept. - Sugar sales procedure, cost of production of sugar, methods of remuneration, pay role, cane payment etc., Personal Dept., - number of Employees and classification, working of time office. Stores – material arrangement, receipts and Issues, purchase procedures & general administration.

up water, working of DM or RO water plant, Feed pumps – RBC – flue gas heat recovery systems viz., Economiser, Air pre heater – secondary air (SA) fan, Forced draft (FD) fan, Induced Draft (ID) fan, chimney, dust collectors, boiler instrumentation. Bagasse Dryer – construction and working, advantages & disadvantages

Starting of boiler - slow firing, rising the pressure, pressure maintenance – low boiler pressure, back feeding – water high/low other operational problems and solutions. Log book, staffing (boiler attender, fireman, gauge glass attender etc.) Off-seasonal work. Flue gas & boiler water analysis.

#### **POWER HOUSE & ELECTRICAL DEPT.**

Turbine, Alternator, AVR-Load distribution – turbine heating, charge over power factor, specific stem consumption-solving problems like priming, low boiler pressure. Power production and distribution, Cogeneration Station, off seasonal job, staffing pattern (Turbine operator and foreman )

Maintenance jobs of Electrical dept – tripping of motors, winding of motors etc.

#### **In plant Training-II**

##### **CLARIFICATION SECTION**

Juice Heating : Arrangement and distribution – heating surface, number to tubes, passes and other design parameters – steam/vapor utilization, temperature control taking and cutting heater from service, juice draining, cleaning, checking – double beet valves etc., - condensate extraction and pumping arrangement, non-condensable gases removal. Operational problems viz., Hammering, problems in pumping, leakage.

Preparation of MOL, lime consumption, capacity, storage and pumping, equipment details. grit removal - classifier, importance of quality of lime.

Production of SO<sub>2</sub>: Operation of sulphur burner, equipment details, control of sulphur burning rate, temperature controlling, automation of burner. Types of valves, Working of compressor/blower.

SULPHITER: Design of sulphiter, Juice sulphitation technique, proportioning of SO<sub>2</sub> gas and MOL, settling test, technical details - capacity, retention time, operation of equipment, draining of juice during stoppage, juice tanks/monds & pumps, Syrup sulphitation.

Off-seasonal maintenance work in the above stations

CLARIFIER: Technical details of clarifier, preparation of flocculant, dosing, flash tank, operation in underflow and overflow, checking juice and mud level, problems in settling, importance of pH & temperature of clear juice, preservation of juice during shut down,

FILTRATION: Technical details, bagacillo blower, cyclone separator, mud mixer, proportioning of mud and bagacillo, operation of filter, creation of vacuum, details of vacuum pump, baby condenser, moisture trap, vacuum regulation(Heavy/Light), filtrate receiver, washing of cake, judging the operation by observing the colour and thickness of the cake. Troubles in filtration, off-seasonal work in the section

EVAPORATION: Working of multiple effect evaporator/falling film evaporator/semikestner, how to start the evaporator, how to distribute the vacuum, juice level regulation, noxious gas removal, condensate extraction, syrup pump trouble, high level in the bodies, vapor bleeding, vacuum problem.

**Project Report preparation.**

\* \* \* \* \*