

**SYLLABUS**  
**SUGAR ENGINEERING CERTIFICATE COURSE**  
**FIRST YEAR**  
**(S.E.C.C.)**

**SUBJECT: SUGAR TECHNOLOGY(THEORY)**  
**CODE: EC/101**

**MAX. MARKS: 50**

1. Brief idea about manufacture of Raw, Plantation white Sugar and refined Sugar.: Juice extraction from sugarcane; Maceration and imbibition; Different maceration schemes; Use of cold and hot water for maceration; Importance of mill sanitation.
2. Measurement and weighment of Juice water measuring tanks, heaters, single and double beet valves, use of vapour and steam in heaters.
3. Juice heaters- Operation of tubular and plate type juice heaters, Single and double beet valves, Use of Vapour and steam in heaters.
4. Specifications of lime and sulphur used for clarification of juice. Air used for SO<sub>2</sub> production, Lime Kilns. Operation of lime slaker, lime classifier, batch and continuous sulphur furnaces, Importance of gas cooler and gas scrubbers.
5. Composition of cane and cane juice; different processes of cane juice clarification-defecation, double sulphitation (continuous liming and sulphitation), Phosphotlation and carronation process of melt clarification comparison of different clarification methods.
6. Preliminary idea about settling-settling rats and factors affecting it, Stoke's Law, batch settling, continuous settling its advantages over batch settling; types of continuous clarifiers (Graver, Rapi Dorr,444 etc.) and their details of working. Importance of settling aids and disinfectants in clarifiers.
7. Types of filters-Plate & Frame type filter presses, their construction and operation. Rotary Vacuum filter, its construction and details of its operation, pressure filtration, leaf filters, Deep head filters and Decanters.
8. Capacity of machinery & equipments  
Selection of site, cane feeding, cane carrier, cane knives; power required for cane carrier, cane knives & mills; crushing capacity of milling tandems and power required; boilers, maceration pumps, mixed juice pumps, mixed juice tanks, mixed juice weighment scale, lime kiln, lime slaker, lime storage tanks, milk of lime pumps, sulphur furnaces, air compressors, juice heaters, juice sulphiter, continuous clarifiers, vacuum filters, plate & frame filter presses for carbonation and sulphitation factoriers. Evaporators, condensers, injection and spray pumps, condensate extraction pumps, syrup sulphiter, syrup pump, syrup and molasses tanks, supply tanks, vacuum pans, crystallizers, batch and continuous centrifugals machines.

**9. Chemical Control:**

Milling control- Technical definitions, calculation of brix percent bagasse, fibre percent bagasse, fibre percent cane, undiluted juice lost in bagasse percent fibre, added water percent fibre, added water extracted in mixed juice percent added water, primary and secondary mill extraction, ideal extraction, mill extraction, brix curves, brix free cane water. Dirt and foam correction, reduced mill extraction, E.R.Q.V. ratios, mill sanitation, comparison of milling efficiencies of factories. Capacity utilization.

**Boiling House Control:**

Brix balance, pol balance and non-sugar balance, Clarification efficiency, E.S.G. value of commercial sugar, Boiling House recovery, Basic Boiling House Recovery, Boiling House performance and Boiling House Recovery (ESG), Reduced Boiling House Recovery. Noel Deer and Gundu Rao Reduced overall extraction.

**Reference Books:** 1- Principles of Sugar Technology, Vol 1-3 by Peter Honig, Elsaevier Poh, Co., Newyork.  
2- Training manual for sugar mills by Mangal Singh, Somaiya Pvt. Ltd. Mumbai.

**SUBJECT: CHEMICAL ENGINEERING**  
**CODE: EC/102**

**MAX. MARKS: 50**

**1. Introduction to chemical engineering.**

1. Concept of unit operation and unit processes
2. Mass and energy balance computation and application to steam generation process.

**2. Process fluid mechanics.**

1. Bernoulli's theorem and its applications to compressible and incompressible process fluids.
2. Process pumps- Classification, selection and sizing.
3. Process piping and pipe components. Pipeline sizing for steam and condensates; Juices, molasses and Maseccuits as per standards and codes(ASME 31.3) – Modes of failure of piping systems.

**3. Process heat transfer.**

1. Conductive Convective and radiant heat transfer. Boiling and condensation. Effect of parameters in sugar process and operating conditions .
2. Selections and sizing of heat exchange equipments- heaters, condensers and condensate heat recovery systems.

**Reference Book**

1. Geanhoplis
2. Ghosal/ Sanyal/ Dutta
3. Heat Transfer- B.K. Dutta

**SUBJECT: SUGAR ENGINEERING**  
**CODE: EC/103A**

**MAX. MARKS: 60**

1. Cane handling: Different systems and equipments used with details in brief.
2. Cane Carrier: Slope, length, speed, width, power consumption etc.
3. Cane Preparation: Principle, Construction, power consumption, assessment of cane preparation (bulk density, preparatory index) by knives, Fibriizer, Shredder, etc.
4. Mills: **Types**, Function, different types of housings, roller groovings, pressures in milling , hydraulic pressure calculations, mill feeding devices, mill drives.
5. Boilers: Types of boilers used in Sugar plants, furnaces, super heaters, Economiser, Air Pre-heater, Calculations, testing and complete heat balance calculations.

**SUBJECT: INSTRUMENTATION**  
**CODE: EC/103B**

**MAX. MARKS: 40**

1. Terminology: Terms associated with Instrument Technology like accuracy, precision, calibration etc.
2. Transducers; Classification of transducer, criterion for selecting a transducer, use of Transducer in measurement of process variables in sugar industry.
3. Pressure: Definition, different types of pressure like Gauge pressure, Atmospheric pressure and absolute pressure-relation between them. Units of pressure and relation between them. Measurement of pressure by manometer: Simple U tube type.
4. Vacuum: Definition, measurement of vacuum by U tube mercury manometer.
5. Elastic devices: Bourden tube, Diaphragm and Bellows: Construction and working of a 'C' type bourden tube type pressure gauges, construction and working of vacuum gauges, its error and how to remove them. Its calibration procedure. Application of Diaphragm and Bellows.
6. Measurement of temperature: Filled system thermometer, gas filled, vapour pressure filled and liquid filled thermometer. Construction and working of gas filled, vapour pressure filled and liquid filled thermometer. General discussion on its merits and demerits and range of application etc. Resistance thermometer: Elements, construction, working theory and application. Thermocouple: Different types, ranges, construction, working theory and application. Pyrometer: Different types, construction, working theory & application.

7. Measurement of flow: Orifice plate; Flow measurement with the help of orifice plate. Accuracy and area of application.  
Rotameter: Construction, working theory, accuracy and application.
8. Measurement of level: Sight gauge glass, float and counter weight type.

**Reference Book:- Industrial Instrumentation and Control- S.K. Singh.**

**SUBJECT: ELECTRICAL ENGINEERING & MECHANICAL ENGINEERING**  
**CODE: EC/104** **MAX. MARKS: 100**

1. **Properties of Steam:** Use of steam tables, specific volume, internal energy of steam, dryness fraction, dry, saturated & super heated steam calculations etc.
2. **Combustion of Fuel:** Principles, theoretical air and total air required for combustion of fuels, combustion products, Calculations.
3. **Boiler:** Classifications, Mountings and accessories, Draught, construction of different types of boilers, operation, performance, Calculations.

**(B) ELECTRICAL ENGINEERING**

1. **DC Motor:** Principle of operation of DC motor, Construction features of DC motor, Classification of DC motors, Electromagnetic torque equation of DC motor, Losses in DC motor, Starting/ Braking of DC motor, Speed control of DC motors, Applications of DC motor
2. **DC Generator:** Principle of operation of DC generator, Construction features of DC generator, Classification of DC generators, EMF equation of DC generator, Losses in DC generator, Parallel operating conditions of DC generator, Applications of DC generator
3. Concept of electric drives, Concept of DC drives, Various speed control methods of DC motor.
4. **Transformer:** Principle of operation of transformer, Construction features of transformer, EMF equation of transformer, Classification of transformers, Losses in transformer, Transformer efficiency, OC & SC tests of transformer, Transformer taps, Parallel operating conditions of transformer, Auto transformer, Instrument transformer, Applications of transformer
5. Direct & Alternating current, Basics of R/L/C circuits, Vector diagrams, Electrical resonance, Active/ Reactive/ Apparent powers, Three phase star and delta connections.

**Reference Books-**

1. **A Text Book of Electrical Technology by B.L. Theraja**
2. **Fundamental of Electric Machines by B.R. Gupta & Vandana Singhal**

**SUBJECT: DRAWING & DESIGN**  
**CODE: EC/105** **MAX. MARKS: 100**

1. **JUICE HEATER :**  
**THEORY**

Objective and function of juice heaters.

Design procedure of juice heaters for given heating surface & crushing rate, calculation of total no. of tubes, no. of tubes per pass, no. of passes, no. of compartments, dia of tube plate, thickness of tube plate & calendria shell, size of juice inlet/outlet, size of steam inlet, size of condensate outlet and vent pipes etc.

**PRACTICAL**

- i. Drawing of general arrangement,
- ii. Drawing of top and bottom headers.

2. **EVAPORATOR:**  
**THEORY**

Objective and function of evaporator **including rising/falling film bodies.**

For given heating surface calculation of total no. of tubes, dia of tube plate and down-take, thickness of tube plate, calendria shell & vapour body. Size of juice inlet and outlet, size of steam inlet, size of condensate outlet and venting pipes. Design of internal catch-all.

#### PRACTICAL

- i. Drawing of top and bottom tube plate showing steam gullies, tie-rods, ventings, condensate removal etc.
- ii. Drawing of catch – all
- iii. General arrangement drawing of evaporator.

#### 3. FINAL MOLASSES STORAGE TANK: THEORY

To calculate the dia and height of molasses tank, selection of width of course, calculation of no. of courses, thickness of each course. Brief idea on various longitudinal and transvers welded joints used in fabrication of molasses tank shell.

#### PRACTICAL

Drawing of molasses tank shell.

#### 4. THEORY

Fundamental of Computer Aided Drafting & Designs.

Practices on Computer Aided Drafting & Designs in Auto Cad Lab.

### **SYLLABUS** **SUGAR ENGINEERING CERTIFICATE COURSE** **SECOND YEAR** **(S.E.C.C.)**

**SUBJECT: SUGAR TECHNOLOGY(THEORY)**

**CODE: EC/201**

**MAX. MARKS:50**

1. Single and multiple effect evaporation, Vapour cell (Robert type) and semi-Kestners. Economy and capacity of evaporator; Vapour bleeding; Scales formation and their effect on efficiency of evaporators, removal of scales, removal of condensate and in-condensable gases, causes of entrainment and remedial measures for checking.
2. Syrup treatment for white sugar manufacture.
3. Different methods of graining. Merits of true seeding graining method over other methods; 2,3 and 4 Massecuits boiling schemes giving purities of syrup, Massecuits, molasses etc.; false grain and conglomerate type of vacuum pans-Coil and Calendria pans. Circulation inside pans, pan control instruments.
4. Specifications of raw sugar. A brief description of the process for its production. Storage of raw sugar.
5. Different types of air cooled, water cooled and vacuum crystallizers. Treatment of low grade Massecuits in crystallizers.
6. Rotary sugar driers, grass hopper drier elevators, sugar graders.
7. Indian Standard Specifications of plantation white sugar, Refined sugar and Raw Sugar.

#### **Factory Practical:**

Study the Construction and operational technique of boiling house equipments in Experimental Sugar Factory.

**Reference Books:-** 1- Cane Sugar Manufacturer in India by D.P. Kulkarni, STAI, New Delhi  
2- Hand Book of cane Sugar Engineering by E. Hugot, Elsevier Puh. Co. Ltd. New York.

**SUBJECT: CHEMICAL TECHNOLOGY & ENGINEERING****CODE: EC/202****MAX. MARKS: 50****1. Introduction to leaching and extraction process.**

1. Basic principals – Equilibrium stages and stage efficiencies, single, cross current and counter current operations.
2. Application of fundamental principals to cane sugar milling and imbibitions processes and to diffusion in beat sugar manufacture.
3. Chemical Engineering analysis of equipment for milling and diffusional operations.

**2. Process and waste water engineering.**

1. Basic principal of waste water engineering – primary secondary and tertiary treatment
2. Water treatment practice in sugar manufacture. Concept of zero discharge, treatment, recovery and reuse of waste water standards for sugar industries.
3. Process water and condensates- Selection and sizing of storage, piping and heat recovery systems.

**Reference Books:-** 1. Mass Transfer by Treybal

2.Environmental Pollution Control by C.S. Rao

**SUBJECT: SUGAR ENGINEERING****CODE: EC/203****MAX. MARKS: 100**

1. Mill gearings, mill speeds, mill settings, power requirements, mill capacity calculations, mill performance, etc.
2. Diffusion and Diffusers- Introduction and comparison with milling systems
3. Boiler Feed Water, quality, control and systems.
4. Steam accumulators, reducing valves and de-super heaters.
5. Pressure reducing valves and de-super heaters.
6. Prime movers: Estimation of power requirements and exhaust production in the sugar factory.
7. Process steam consumption and heat balance calculations.
8. Conservation of Heat: Heat losses and their prevention by lagging, different types of steam traps etc.
9. Different types of pumps used in the sugar factories.
10. Preventive and Predictive maintenance in the sugar factory.

**SUBJECT: ELECTRICAL ENGINEERING****CODE: EC/204****MAX. MARKS: 50**

1. Principle of operation of induction motor, Construction features of induction motor, Classification of induction motors, Electromagnetic torque equation of induction motor, Slip-torque curve of induction motor, Losses in induction motor, Starting/ Braking of induction motors, Single phasing of induction motor
2. Utilization of induction motors in sugar industry, Various speed control methods of induction motor including variable frequency drive (VFD) control method in detail.
3. Principle of operation of synchronous generator, Construction features of synchronous generator, Excitation system of synchronous generator, Classification of synchronous generator, Parallel operating conditions of synchronous generator.
4. Concept of power generation, power transmission and power utilization in sugar industry, Methods for reduction of captive power consumption.
5. Introduction of various types of switch gears (switches, circuit breakers, fuses, relays etc.) used in sugar industry, Power factor, Disadvantages of lower power factor, Causes of low power factor and ways to improve it.

### Reference Books-

1. A Text Book of Electrical Technology by B.L. Theraja
2. Fundamental of Electric Machines by B.R. Gupta & Vandana Singhal
3. Principles of Power System by V.K. Mehta, Rohit Mehta

### SUBJECT: MECHANICAL ENGINEERING

CODE: EC/205

MAX. MARKS: 50

#### 1. Steam Turbines:

Classification of steam turbines, Impulse and Reaction turbines, condensing, extraction-cum-condensing, back pressure, single stage; multistage turbines. Different types of Efficiencies, Compounding & Governing of steam turbines.

#### 2. Steam Condensers:

Function of condensers, Elements of Condensing Plant, Types of Condensers- Surface & Jet Condensers, Estimation of Cooling Water Required, Condenser Efficiency, Air Extraction, Cooling Towers, Cooling Ponds.

#### 3. Pumps:

Types of Pumps, Centrifugal & Reciprocating Pumps- Construction & Working, Heads & Efficiencies, Comparison of centrifugal & reciprocating pumps, Net Positive Suction Head (NPSH), Priming of pumps.

#### 4. Air-Compressors:

Classification of air-compressors, Reciprocating and Rotary air compressors- Construction & Working, Air blowers, General working principles in respect of their capacity and pressure calculations, Utilization of compressors in the sugar industry.

### SUBJECT: INSTRUMENTATION

CODE: EC/206

MAX. MARKS: 50

1. Introduction to control system: Open loop and closed loop system. Types of control action such as- two step control, proportional control, integral control, proportional and integral control, derivative control and proportional, integral and derivative control, Electronic controllers (CP, PT, PD, PID).
2. Control Valve: Construction, flow characteristics of control valve, valve body material, selection of control valve & valve positioner.
3. Introduction to pressure switch and its use in sugar factory annunciation system.
4. De-superheating station: Pressure and temperature control..
5. Digital Technology: - Data Communication. Data Acquisition, PLC, DCS, Elements of a DCS. Data Highway, Digital field transmitter based on smart technology.
6. DCS/PLC control system and its application for mill and boiler control.
7. Basic parameters for auto combustion control and three element level control system for boilers.

**Reference Books**—1. Instrument Technology, Vol.1-4 by E.B. Jones, English Language Book Society Ltd., Butterworths

2. Instrument Engineers Hand Book by B. G. Liptak, Butterworths Heinmann Ltd., Oxford.

3. Process Control Instrumentation Technology by Curtis D. Johnson, Pearson Publication.

### SUBJECT: DRAWING & DESIGN

CODE: EC/207

MAX. MARKS: 100

#### 1. MILLS:

- (A) THEORY: Design of mill roller shaft & shell, Design of rake carriers. Design of various feeding devices like under feed roller, Donnelly chute, Pressure feeders – G.R.P.F. and T.R.P.F.

(B) PRACTICAL Drawing of trash plate profile. Drawing of Donnelly chute and under feeder alongwith a three roller mill. Drawing of feed hopper, continuous pressure feeder alongwith three roller Mill.

2. PAN:

(A) THEORY

Objective and function of Pan

Design procedure of batch type Pan:- To calculate no. of tubes for given pan heating surface, dia of tube plate and down take, graining volume and strike level of pan, thickness of calendria shell & body. Design of catch- all and vapour pipe. Brief description of continuous pan.

(B) PRACTICAL

i. Drawing of top and bottom tube plate, showing steam gullies, tie-rods, ventings, condensate removal etc.

ii. Drawing of catch-all.

iii. General arrangement drawing of pan.

3. CONDENSER:

(A) THEORY

Objective and function of condenser.

Design procedure of Barometric and multijet condensers: Baffle type, rain & shower type, Multijet condenser with separate spray & jet nozzle Barometre Condenser with box as well as combind jet and spray box. To calculate the dia and height of condenser, quantity of injection water required and air to be removed from the system, size of injection water and air pipe, size and no. of spray and jet nozzles in case of multijet condenser, size of tail pipe, size of sealing pipe etc.

(B) PRACTICAL

Drawing of Barometric and Multijet Condenser.- Seneral Arrangement

4. CRYSTALLIZERS:

(A) THEORY

Objective and function of crystallizers. Design procedure of air cooled and water cooled crystallizers :- Batch & Continuous. To calculate size of crystallizer, shaft dia, cooling surface for batch & continuous crystallizer.

(B) PRACTICAL

Drawing of water cooled crystallizer.

5. PRACTICAL

Practical on Computer Aided Drafting & Design in Auto Cad Lab.

## **SUBJECT: SUGAR TECHNOLOGY (PRACTICAL)**

**CODE: EC/208**

**MAX. MARKS: 50**

1. Determination of following constituents in juices & molasses:  
(i) Brix (ii) Pol (iii) Apparent purity (iv) pH (v) Reducing sugars (by Lane Eynon Method)
2. Determination of sucrose and calculation of gravity purity in juices and molasses  
By Jackson and Gills Method
3. Analysis of sugar for Pol and moisture per cent determination.
4. Analysis of bagasse for (i) pol per cent and (ii) Moisture percent.
5. Preparation of solutions and determination of sugar traces by  $\alpha$ - Naphthol Test in condensate water and boiler feed water.
6. Determination of pH, hardness and alkalinity etc. in condensate water and boiler feed water.
7. Determination of Preparatory Index of the prepared cane.

**SUBJECT: MECHANICAL ENGINEERING****CODE: EC/205****MAX. MARKS: 50**

1. Steam Engines: Classification, its parts and their functions, testing of engines.
2. Steam turbines: Classifications, Compounding, Specific steam consumptions, different types of efficiencies, Calculations. governing of steam turbines.
3. Reciprocating & Rotary Air Compressors, Classification, principle & operation calculation.
4. cooling Ponds and cooling towers:-  
Necessity of cooling the condenser water, condenser water cooling system. Introduction to cooling to cooling ponds, classification of cooling tower, presentation of carryover losses and fog formation from cooling towers, performance of cooling towers, etc.

**SUBJECT: INSTRUMENTATION****CODE: SE/206****MAX. MARKS: 50**

1. Introduction to control system: Open loop and closed loop system. Types of control action such as- two step control, proportional control, integral control, proportional and integral control, derivative control and proportional, integral and derivative control. Pneumatic controller, Electronic controller.
2. Control Valve: Construction, types of body, flow characteristics of control valve, valve body material, selection of control valve & valve positioner.
3. Introduction to pressure switch and annunciation system.
4. De-superheating station: Pressure and temperature control..
5. Digital Technology: - Data Communication. Data Acquisition, PLC, DCS, Elements of a DCS. Data Highway, Digital field transmitter based on smart technology.
6. DCS/PLC control system and its application for mill and boiler control.
7. Basic parameters for auto combustion control and three element level control system for boilers.

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2. Instrument Engineers Hand Book by B. G. Liptak, Butterworths Heinmann Ltd., Oxford

**SUBJECT: DRAWING & DESIGN****CODE: EC/207****MAX. MARKS: 100**

1. MILLS:  
(C)THEORY: Design of mill roller shaft & shell, Design of rake carriers. Design of various feeding devices like under feed roller, Donnelly chute, Pressure feeders – G.R.P.F. and T.R.P.F.  
(D) PRACTICAL Drawing of trash plate profile. Drawing of Donnelly chute and under feeder alongwith a three roller mill. Drawing of feed hopper, continuous pressure feeder alongwith three roller Mill.
2. PAN:  
(A)THEORY  
Objective and function of Pan  
Design procedure of batch type Pan:- To calculate no. of tubes for given pan heating surface, dia of tube plate and down take, graining volume and strike level of pan, thickness of calandria shell & body. Design of catch- all and vapour pipe. Brief description of continuous pan.  
(B)PRACTICAL  
iv. Drawing of top and bottom tube plate, showing steam gullies, tie-rods, ventings, condensate removal etc.  
v. Drawing of catch-all.  
vi. General arrangement drawing of pan.
4. CONDENSER:



(A) THEORY

Objective and function of condenser.

Design procedure of Barometric and multijet condensers: Baffle type, rain & shower type, Multijet condenser with separate spray & jet nozzle Barometre Condenser with box as well as combined jet and spray box. To calculate the dia and height of condenser, quantity of injection water required and air to be removed from the system, size of injection water and air pipe, size and no. of spray and jet nozzles in case of multijet condenser, size of tail pipe, size of sealing pipe etc.

(B) PRACTICAL

Drawing of Barometric and Multijet Condenser.- General Arrangement

4. CRYSTALLIZERS:

(A) THEORY

Objective and function of crystallizers. Design procedure of air cooled and water cooled crystallizers:- Batch & Continuous. To calculate size of crystallizer, shaft dia, cooling surface for batch & continuous crystallizer.

(B) PRACTICAL

Drawing of water cooled crystallizer.

5. PRACTICAL

Practical on Computer Aided Drafting & Design in Auto Cad Lab.

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2. Determination of sucrose and calculation of gravity purity in juices and molasses  
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3. Analysis of sugar for pol and moisture per cent determination.
4. Analysis of bagasse for (i) pol per cent and (ii) Moisture percent.
5. Preparation of solutions and determination of sugar traces by  $\alpha$ -Naphthol Test in condensate water and boiler feed water.
6. Determination of pH, hardness and alkalinity etc. in condensate water and boiler feed water.
7. Determination of Preparatory Index of the prepared cane.