

SYLLABUS
ASSOCIATESHIP COURSE IN SUGAR ENGINEERING
FIRST YEAR

A.N.S.I. (Sugar Engineering)

SUBJECT : SUGARCANE AGRICULTURE (THEORY)
CODE : SE/101 **MAX. MARKS : 50**

1. Sugar Producing Crops.
2. History, origin and distribution of Sugarcane, Sugarcane producing countries in the world. Area under sugarcane in different states of India.
3. Cultivation of sugarcane, brief lectures on climatic requirements, preparation of land, period of sowing, cane seed, methods of planting, germination, tillering, irrigation and maturity of sugarcane crop.
4. Nutrition of sugarcane: Major (macro) nutrients, Minor (Micro) nutrients, fertilizer management of sugarcane, Nitrogen, Phosphorus and Potash, sources and their applications: Morphology of sugarcane plant.
5. Deterioration of sugarcane- effect of staling and burnt cane on sugar and fibre content.
6. Plant Protection Measures for sugarcane- major diseases and pests of sugarcane and their integrated control measures.
7. Characteristics of the sugarcane fibre.
8. Mechanization of sugarcane cultivation, harvesting and transportation.

Reference Books- 1. Agriculture of the Sugarcane by A. C. Barnes, Leonard Hill Ltd., London
2. Hand Book of Agriculture by J.D. Jameson, I.C.A.R., New Delhi

SUBJECT : SUGAR TECHNOLOGY
CODE : SE/102 **MAX.MARKS - 100**

1. **Introduction to terminology used in sugar industry.**
2. Juice extraction from cane, maceration / imbibitions, use of cold and hot water, maceration/imbibition scheme, mills sanitation.
3. Measuring and weighing of juice, measuring tanks, level meters, counters, weighing machines; hand operated, semiautomatic and automatic system for online weighment, **juice flow stabilization system.**
4. Juice heaters types and use of vapour, steam **& condensate.**
5. Object of clarification, flow diagram of different processes, composition of sugarcane and juice; lime kilns; lime preparation system ; SO₂ production units; reaction tanks; settling tanks; continuous clarifiers /subsiders, i.e. Rapi Dorr, Graver & short retention types etc., plate and frame filter presses, bag filter, rotary vacuum filter & decanter etc.
6. Brief idea about refined and raw sugar production.
7. **General idea about process flow diagram of Raw, Refined & Plantation white sugar.**

SUGAR MANUFACTURE

1. Evaporation-Principal & different configuration of evaporator sets, single effect and multiple effect evaporation, vapour cell, vapour bleeding, scale formation their removal and effect on the efficiency of evaporation, removal of condensate and incondensable gases, **low tem evaporate module.**
2. Syrup/ melt clarification by Phosphoflotational and carbonation.

MILLING CONTROL

Method of control-differential and inferential control, primary and secondary mill extraction; Brix curves; Java system of chemical control; Dirt and foam corrections, pol accounts, Bx accounts, Miscellaneous calculations; Mill sanitation- E.R.Q.V. (MJ/PJ & LMJ/PJ) etc.

CAPACITY

1. Selection of site, lay out plan of the factory.
2. Cane feeding, cane carrier its width, length and drive, cane preparatory devices, power required

for cane preparation and mills.

3. Crushing capacity for milling tandems, mill drive power, raw Juice and maceration pump capacities.
4. Mixed Juice screening, mixed juice weighing scale, mixed juice measuring tanks.
5. Juice heaters-for their heating surface, capacity of juice sulphitation tanks, sulphur furnaces, air compressors, milk of lime preparation units and pumps.
6. Clarifiers (settling tanks), rotary vacuum filters, filter presses.
7. Evaporators, syrup sulphitation tanks.

Reference Books— 1. Principles of Sugar Technology Vol.1-3 by Peter Honig, Elsevier Pub. Co., New York.
2. Training manual for Sugar Mills by Mangal Singh, Somaiya Pvt. Ltd., Mumbai

SUBJECT : CHEMICAL ENGINEERING
CODE : SE/103 MAX. MARKS : 100

1. Introduction to chemical engineering

- (a) Concept of unit operations and unit processes. Unit operations and processes in sugar manufacture Stoichiometric Calculations.
- (b) Mass and energy balance computation and application to sulphur dioxide & steam generation process. Enthalpy balances in evaporator systems.

2. Process fluid mechanics

- (a) Classification of fluids and fluid flow phenomena. Non-Newtonian fluids in sugar industry practice.
- (b) Bernoulli's Theorem and its applications to compressible and incompressible process fluids.
- (c) Process pumps-classification, selection and sizing. Parallel and series arrangement. Pumping practice in sugar manufacture.
- (d) Process piping and pipe components. Pipeline sizing for steam and condensates; juices, molasses and massecuite as per standards and codes (ASME 31.3)-Modes of failure of piping systems. Piping networks.

3. Process heat transfer

- (a) Conductive and Convective and radiant heat transfer. Boiling and condensation. Effect of various parameters on sugar process and operating conditions.
- (b) Selection and sizing of heat exchange equipments- heaters, condensers and condensate heat recovery systems, evaporators-

Reference Books—1. Introduction to Chemical Engineering by Badger & Banchero
2. Unit Operation of Chemical Engineering by W.L. McCabe & J.C. Smith Mc Graw Hill co., New York
3. Transport Process and Separation Process Principles by Chemist John Geanopolis (PHI)
4. Heat Transfer: Principles and Applications by B.K. Dutta (PHI)
5. Introduction to Chemical Engineering- Ghosal/ Sanyal/ Datta (Tata Mcnaw-Hill)

SUBJECT : SUGAR ENGINEERING
CODE : SE/104 MAX. MARKS : 100

SUGAR ENGINEERING-MILLING

1. CANE HANDLING

Modes of transportation, Percentage of cane supply by different modes and their effect on cane unloading systems. Unloading of cane by different systems and equipments. Overhead traveling crane (two and three motion grab and sling bar system, Both mechanical and Hydraulic type with

their advantages and disadvantages), Provision for cart unloading, truck-tippler, Trolley tippler, lateral feeder table, auxiliary cane carrier (dimension, speed and power) , Hilo unloaders.

2. CANE CARRIER

Types of cane conveyors. Advantages and disadvantages of each type, Determination of slope, length, speed, width and power consumption for each type. Different methods of drives, cane carrier controls, equalizer (speed and power). Tramp Iron Separator.

3. CANE PREPARATION

Principle and design of different types of cane preparatory devices, kicker, chopper, leveler and cutter, Head-on-cutter, fibrizer, shredders, on line shredder, mincer. Methods of their drives i.e., steam engines/steam turbines/electric motors. Types of couplings, speed of rotation and power requirement- principle, different types; methods of drives, speed and power requirement of shredder, fibrizer and Mincer. Assessment of bulk density and preparatory index and their methods of analysis.

4. MILLS

Function, different types of housings, squire housing, inclined housing, self setting mill and constant ratio mill, Two roller Mill, cast steel and fabricated housing; trash plate and its function, trash beam, mill rollers, bearings, pinions, roller scrappers, juice rings.

5. MILL FEEDING

Equation governing the mill feeding in a three roller mill , self-feeding angle, angle of tip, angle of contact, open and closed gravity chutes, continuous pressure feeder- light duty and heavy duty; intermediate carriers, rotary feeders, dirty top roller.

Milling terms like Novoid Volume, Escribed Volume, Compression Ratio, Filling ratio, Capacity Number, etc.

6. PRESSURE IN MILLING

Pressure-volume relationship, reabsorption factor, compression ratio, filling ratio, fibre loading, specific fibre loading, hydraulic pressure, specific hydraulic pressure, polygon of forces in a mill, distribution of pressure on feed and discharge rollers, equation for the pressure developed on a roller, pressure regulating appliances-hydraulic accumulators(dead weight, pneumatic and air oil type). Calculations of hydraulic pressure, sequence of hydraulic pressure in the milling tandem, horizontal reaction and measure to control, pinion reaction and measures to control.

7. IMBIBITION

Principle, different systems of imbibition, methods of application of imbibitions system, hot and cold imbibition, optimum imbibition and its efficiency.

8. MILL CAPACITY AND PERFORMANCE

Factors affecting mill capacity and performance, such as, cane preparation, specific hydraulic loading, length of tandem, roller speed, specific fibre loading and imbibition.

SUGAR ENGINEERING – BOILERS AND PRIME MOVERS

1. COMBUSTION OF FUELS

Chemical composition of bagasse, air for combustion, products of combustion, excess air and percentage of CO₂. Calorific value- gross calorific value and net calorific value, heat loss in flue gases, loss due to incomplete combustion.

2. FURNANCE

Different types of furnaces for bagasse, i.e., step grate, horse shoe, ward, spreader stoker, travelling and dumping grate. Requirement of grate area, furnace volume, combustion chamber volume and application of secondary air. Performance of different types of furnaces-capacity of burning of fuel per unit grate area. Limitation of these furnaces and their relative merits and demerits.

BOILER HEAT BALANCE

Boiler efficiency, condensation loss, sensible heat loss, unburnt and unknown losses. Estimated quantity of steam obtainable, weight of steam per unit weight of fuel. Typical examples, observations and analysis for determination of boiler efficiency. Methods of improving the boiler efficiency.

3. SUPER HEATER

Different types of super heaters-convection and radiation, their location in the flue path. Calculation of heating surface, degree of superheat.

4. ECONOMISER

Different types of economizer-vertical and horizontal, plain tubes and finned tubes, their merits and demerits, role and limitations in improving boiler plant efficiency, assessment of fuel saving, determination of heating surface and checking the performance of an existing installation.

5. AIR HEATER

Different types of air heaters-Tubular and Plate type. Limitations of these air heaters. Determination of heating surface, checking of the performance of a existing installation. Flue gas recirculation, comparison between air heater and economizer. Possibilities of installation of air heaters and economizer in a boiler plant.

6. DRAUGHT

Natural and artificial draught, balanced draught, chimney-location, calculation of height and cross-sectional area. Mechanical draught systems-forced and induced draught, ejector draught. Types of impeller blades, fan and their efficiencies, capacities of different fans and their power requirement.

7. FEED WATER

Use of condensate, make up water, temporary and permanent hardness. Method of treatment. Internal treatment of boiler components. External treatment-water softener and demineralisation plants. The effect of oxygen on corrosion, deaerators. caustic embrittlement.

8. PRESSURE REDUCING AND DESUPERHEATING OF STEAM

Their description and working, merits and demerits, typical layout of steam reducing valves and precautions for their smooth operations. Need of a de super heater, typical layouts and design of de super heater.

High pressure Boilers. Advantages of high pressure Boilers.

Introduction, Benefits of Co-generation Potential for exportable power.

9. Incineration boilers- Description , application with respect to Distilleries & drawback.

Reference Books—1.Machinery & Equipments of Cane Sugar Factory by L.A.Tromp, Twentieth Century ,New Delhi

2. Hand Book of Cane Sugar Engineering by E. Hugot, Elsevier Pub. Co., New York

SUBJECT : EQUIPMENT DESIGN & GENERAL ENGINEERING

CODE : SE/105A MAX. MARKS : 50

PART – A – MECHANICAL DESIGN

1. General Design Considerations: Functional design, Production design & Maintenance design. Economic considerations.
2. Methods of Fabrications: fusion welding, welding standards. Types of welded joints, Fillet and Butt joint and their details. Calculation of strength of different welding joints.
3. General Design Procedures: Study of B.I.S. codes, their application to the equipment. Failure criteria - excessive elastic deformation, elastic instability, plastic instability, brittle rupture, creep & corrosion.

SUBJECT : EQUIPMENT DESIGN & GENERAL ENGINEERING
CODE : SE/105B MAX. MARKS : 50

GENERAL ENGINEERING

Basic principles of process engineering & design

1. **Introduction:** General features of sugar manufacturing process and equipments. Structures and buildings-open and sheltered structures, gravity & non-gravity plants and their layouts.
2. **Engineering economics:** Economic criteria in process engineering and design. Measures of profitability. Depreciation, amortization, capitalized costs and present and future value and internal rate of return. Project evaluation. Energy economics and carbon credits.

Reference Books— 1.Computer Aided Design in Mechanical Engineering by V. Ramamurthy,Tata mc Graw Hill pub. Co. Ltd., New Delhi

2.Plant Design and Economics For Chemical Engineers by Peter Timmerhaus, McGraw Hill Co. Ltd.,New York

3. Chemical Engineering Design- Coulson- Richardson (Vol-6) Elsevier Publication

SUBJECT : ELECTRICAL ENGINEERING
CODE : SE/106 MAX. MARKS : 100

1. **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
2. **D.C. Machines:** Construction features of DC machines, Principle of operation of DC motor/ DC generator, Classification of DC motors/ DC generators, Electromagnetic torque equation of DC motor, EMF equation of DC generator, Losses in DC machines, Starting/ Braking of DC motor, Parallel operating conditions of DC generator, Applications of DC motor / DC Generator.
3. **A.C. Machines: Induction Motors:** 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 (direct on line, star-delta and auto-transformer)/ Braking of AC motors, Single phasing of AC motor.
4. **Electric Drives:** Concept of electric drives, Various speed control methods of DC motor, Various speed control methods of induction motor including variable frequency drive (VFD) control method in detail, DC Drive & AC Drive advantage and disadvantage.
5. **Power Factor:** Concept of power factor, Disadvantages of lower power factor, Causes for low power factor, Power factor correction methods, Remedial measures to improve the power factor in sugar industry.

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. **Fundamentals of Electrical Drives by Gopal K Dubey.**

SUBJECT : DRAWING & DESIGN
CODE : SE/107 MAX. MARKS : 100

1. **JUICE HEATER :THEORY :**
Functional and constructional details, material of construction and its properties, various types of juice heaters-Dead-end & Dynamic juice heaters. For given crushing rate, calculation of heating surface, total number of tubes, number of tubes per pass, number of passes, number of

compartments, diameter of tube plate, size of steam inlet, juice inlet/outlet, condensate outlet, non condensable gas outlet, thickness of tube plate, calendria shell, cover plates, etc.

(a) PRACTICAL:

- (i) Drawing of General Arrangement,
- (ii) Drawing of top and bottom headers.

2. EVAPORATOR:THEORY:

Types : Roberts, Semikestner-rising & falling films, functional and constructional details, Material of construction and its properties. For given heating surface determination of total number of tubes, diameter of tube plate, diameter of down – take, body diameter and height, calendria shell thickness, tube plate thickness, body thickness. Calculation of vapour inlet, juice inlet/outlet, condensate outlet, non condensable gas outlets. Design of internal catch all.

- (a) PRACTICAL:
- (i) Drawing of general arrangement.
 - (ii) Drawing of tube plate
 - (iii) Drawing of catch-all.

3. FINAL MOLASSES TANK:

(a) THEORY :

Constructional and functional details, material of construction and its properties Determination of number and capacity of molasses tanks for a given capacity of sugar factory. Calculation of optimum tank proportions: Diameter of tank, filling height and total height of tank, number and thickness of each course, standard width of courses, thickness of bottom plate.

(b) PRACTICAL: Drawing of molasses tank.

4. MILLS:

- (a) THEORY: Design of mill roller – shaft, journals and CI shell. Theory of failure of mill rollers.
- (b) PRACTICAL: Drawing of Trash Plate Profile.

5. THEORY: Designee basis of Hydraulic motor.

PRACTICAL: Drawing & Hydraulic Motor.

6. THEORY: Equipments of computer Aided Drafting & Designs.

PRACTICAL: Practice on Computer Aided Drafting & Deigning in Auto Cad Lab.

Reference Books— 1.Computer Aided Designs in Mechanical Engineering by V. Ramamurthy, Tata Mc Graw Hill Pub. Co. Ltd., New Delhi
2.Hand Book of Cane Sugar Engineering by E. Hugot, Elsevier pub. Co.,New York

SUBJECT : INSTRUMENTATION

CODE : SE/108 MAX.MARKS : 50

1. Terminology: Term associated with Instrument Technology like accuracy, precision, calibration etc.
2. Pressure: Definition, different types of pressure like Gauge Pressure, Atmospheric Pressure and Absolute pressure, relation between them. Units of pressure, measurement of pressure, Pressure Indicator, Pressure Recorders.
3. Vacuum: Definition, measurement of vacuum by vacuum gauge and U tube manometer.
4. Elastic devices: Bourdon tube, Diaphragm and Bellows, construction and working of a ‘C’ type Bourdon tube pressure gauge, construction and working of vacuum gauges, its error and method for removal, calibration procedure. Application of Diaphragm and Bellows.
5. 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. Its merits and demerits and range of application. Resistance thermometer: Elements, construction, working theory and application. Thermocouple: Definition, different types, ranges, construction, working theory and application. Pyrometer: Definition, different types, construction, working theory and application.
6. 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. Electromagnetic Flowmeter: Working principle, construction, maintenance, area of application.

7. Measurement of level: Sight gauge glass, counted weight type, air purge type, Buoyancy type
8. Measurement of pH: Construction of electrodes, maintenance of electrodes, circuit diagram. Measurement of Conductivity.
9. Boiler Instrumentation:
Pressure measurement of steam, use of pig tail siphon for such measurement.
Flow measurement of steam by orifice plate and differential pressure transmitter. Use of condensate pot for such measurement.
Boiler drum level measurement by sight gauge glass method.
Draught gauges. Flue gas temperature, steam temperature, boiler feed water temperature measurement by thermocouple. Oxygen Analyzer.

Reference Books—1. Instrument Technology, Vol.1-4 by E.B. Jones, English Language Book Society, Butterworths 2. Industrial Instrumentation and Control by S.K. Singh (Tata McGraw- Hill)

ASSOCIATESHIP COURSE IN SUGAR ENGINEERING

SECOND (FINAL) YEAR

SUBJECT : STATISTICS

CODE : SE/202 MAX. MARKS : 50

1. Definition, scope, collections and classification of primary data, frequency distribution and graphical representation.
2. Measure of Central tendency, Dispersion and Skewness.
3. Interpolation and extrapolation (only Newtons' forward and backward formula and Lagrange's formula).
4. Correlation coefficient, total, partial and multiple for three variables only (Elementary knowledge of subject with emphasis on the applied sides by solving numerical problems), Regression equation, Standard error, Fitting of normal curve (without the use of calculating machine). Method of least squares for curve fitting.
5. Testing of hypothesis and tests of significance of means and correlation coefficient (excluding period "T" test) and regression co-efficient.
6. Association of attributes and tests of significance based on Chisquares, contingency table.
7. Sugar statistics data on production, consumption, imports, exports, stock and price of sugar at all India and state level. Manufacture, imports- export of sugar machinery, its prices and other related statistics.
8. Basic of probability and probability distributor function (B,N,P)

Reference Books—Fundamental of Applied Statistics by S.C. Gupta, S. Chand &Co., New Delhi

SUBJECT : BUSINESS MANAGEMENT

CODE : SE/203A MAX. MARKS 25

1. **Management** : Definition, process, importance, concept, fundamental principals scientific management principles. **Project Management**- Features of a project Management, Project life cycle and its phases, Project feasibility study, market feasibility, Technical feasibility, financial feasibility, Pre-regularities for successful implementation of projects. **Environmental Management**- Scope & nature of Environmental Management , Environmental Management system (EMS), Environmental concept, Planing to project the environment, planning for emergencies.
2. **Directing Type**- Direction, Process, motivation concept, types, morale, supervisory leadership, definition, characteristics.
3. Training of operation, Training needs, importance types of training-"on" the job and off the job training.

- 4. Production management function**, definition, production planning, production control
- 5.** Location of factory, layout of plant building factors importance in decision making
- 6.Planning-** concept, definition, types, purpose of decision making , process of decision making
- 7. Cost control: Inventory** control , technique, cost factors of cost in sugar industry, budgetary control.
- 8. Purchase Organization and control-** store keeping recording, centralized and decentralized purchasing, functions of purchase office.
- 9.Business Environmental** – Concept, nature of basis environmental. Element- internal and external, techniques of environmental scanning and monitoring.

Reference Books—1. Industrial Organization & Management by Lowrence L Bethe McGraw Hill Book Co. Ltd, New York
 2. Handbook of Sugar Factory Management by A. R. Upadhyay, Rajiv Sadan, Ratlam, India

SUBJECT : COMPUTER AWARENESS
CODE : SE/203B

MAX. MARKS : 25

UNIT-1 COMPUTER FUNDAMENTALS :-

Chapter -1 Computer Concept : Definition of computer, element of computer, Types of software.

Chapter -2 Parts of a computer : I/O devices, CPU, Auxiliary Storage Devices.

UNIT-2 Operating System :-

Chapter -1 Introduction to operating System, Function of operating System, Classification of Operating System

Chapter -2 WINDOWS : Various features of OS- WINDOWS .

UNIT-3 MS – Office :-

Chapter -1 MS –Word : Basic features of MS-Word Screen, Managing documents.

Chapter -2 MS- EXCEL : Basic of spreadsheet application, creating worksheet file, Doing calculations, creating charts

Chapter -3 MS-Powerpoint : Starting MS power point, Using design templates, Working with slide master.

UNIT-4 Web Technology :-

Chapter -1 Internet basics: Definition of internet, use of internet, internet connection requirement.

Chapter -2 World Wide Web: Understanding www, web sites, browsers

UNIT-5 Visual Basics :-

Chapter -1 VB Environment : Tool Box, Project explorer windows

Chapter -2 VB Application : Creating & Designing form, working with common controls .

UNIT-6 Data Base :-

Chapter -1 Database Basics : DBMS, Functions of DBMS, Types of DB implementation models.

Reference Books:

1. “An introduction to database systems” by Bipin Desai The complete reference visual basics.

SUBJECT :SUGAR TECHNOLOGY (CONTROL & CAPACITY)

CODE : SE/204A

MAX.MARKS 80

1. Type of pans, circulation of masscuite., pan control instruments- bromoscope, micromax, cuitometer, pan refractometer & online instruments based on conductivity control etc.
2. Condensers- barometric and jet including single entry condenser, water requirement, approach temperature & condenser automation.
3. Centrifugals- different types; Basis of selection for different massecuities, driving arrangement, Screen/ mesh arrangements, washing and steaming arrangements, Pug mills. Massecuite heating- use of transient heater etc.

4. Pump requirements for various sugar house Process liquor/materials.
5. Sugar Driers and Graders- Hoppers, & fluidized bed driers, cooling of sugar, bagging temperature, dust collectors, hot & cold air blowing system, safety factor. Graders- type, use of different screens for grading sugar etc., automatic bagging & weighing system.
6. Storage of sugar – Norms for construction of sugar godowns as per BIS, control of humidity, method of stacking etc.
7. Molasses storage tank, storage pits and details of storage conditions.

SUGAR MANUFACTURE

1. Classen's theory of pan boiling, boiling schemes, different systems of graining.
2. Crystallization, water cooling and air cooling, time requirements, growth of crystal, molasses exhaustion, temp. and density control etc, low grade massecuite treatment.
3. Centrifugation and drying.
4. Elementary idea about refining and /Raw sugar manufacture.
5. Specification for Plantation white sugar, refined sugar and Raw Sugar.

BOILING HOUSE CONTROL

1. Sample and methods of sampling. Available molasses calculation, virtual purity of final molasses and molasses loss, press cake loss and calculation of other losses.
2. The definitions of various sugar house products and their uses.
3. Difference between commercial sugar, equivalent standard granulated (E.S.G.) and Java crystal.
4. Calculation of Boiling House Recovery and Boiling House Recovery (E.S.G.).
5. Reduced Boiling House Recovery (Noel Deer & Gundu Rao). Comparison of boiling house efficiency of different factories.
6. Comments on various losses and unknown losses of sugar. overall extraction, Reduced overall Extraction, Time Account.
7. Capacity utilization-rate of crushing/24 hours operation, rate of crushing/22 hours of operation.

CAPACITY

1. Condensers, injection and spray pumps, requirement of cooling (condenser) water, condensate extraction pumps.
2. Vacuum pans, syrup & molasses storage tanks crystallizers, centrifugal machines.
3. Storage of sugar and molasses.

Reference Books—1.Cane Sugar Manufacture in India by D.P. Kulkarni, S.T.A.I.,New Delhi

2. Hand Book of Cane Sugar Engineering by E. Hugot, Elsevier Pub. Co. Ltd, New York

SUBJECT : BY PRODUCTS

CODE : SE/204B

MAX. MARKS : 20

1. BAGASSE: Characteristics of bagasse, production of biogas & biomanure from bagasse, production of pulp, paper and different boards, production of furfural. Use of bagasse for cattle feed. Bagasse gasification.
2. PRESSMUD: Characteristics of press mud, extraction of cane wax – its purification & bleaching, use of sulphitation press mud as manure, production of biogas & biomanure from press mud and use of press mud for biocompost production in distillery.
3. MOLASSES: Different types of molasses & their characteristics, alcoholic fermentation of molasses – Manufacture of rectified spirit & denatured spirit, industrial alcohol, absolute alcohol, potable liquors, manufacture of citric acid, lactic acid, manufacture of bakers yeast.
4. EFFLUENT TREATMENT: Pollution Control Norms, Water Management in sugar production both in Plantation white sugar and refined sugar. Reuse of surplus condensate. Effluent Treatment Plant and its process. Online Monitoring System. Fresh water consumption and control.

Reference Books— By Products of Cane Sugar Industry by J.M. Paturau, Elsevier Pub. Co.Ltd., New York

SUBJECT : CHEMICAL TECHNOLOGY & ENGINEERING

CODE : SE/205

MAX. MARKS : 100

1. Introduction to leaching and extraction process.

- (a) Basic principles- of Diffusion equilibrium stages and stage efficiencies, single, cross current and counter current operations.
- (b) Material balances in leaching processes. Application of fundamental principles to cane sugar milling and imbibition processes and to diffusion in beet sugar manufacture.
- (c) Chemical engineering analysis of equipments for milling and diffusional operations.

2. Process and waste water engineering

- (a) Basic principles of waste water engineering-primary, secondary and tertiary treatment.
- (b) Water treatment practice in sugar manufacture. Concept of zero discharge, treatment, recovery and reuse of waste water. Waste water standards for sugar industries.
- (c) Process water and condensates- Selection and sizing of storage vessels, piping, pumping and heat recovery systems.

Reference Books- 1. Introduction to Chemical Engineering by BadgerBanchero

2. Unit Operation of Chemical Engineering by W.L. McCabe & J.C. Smith Pub.-
McGraw Hill Book Co., New York

3. Mass Transfer operation by Treybal

4. Environmental Pollution Control Engineering by C.S. Rao.

SUBJECT : SUGAR ENGINEERING

CODE : SE/206

MAX. MARKS : 100

ROLLER GROOVING: Function, Types-circumferential grooves, differential angle and differential pitch grooves, coarse and fine pitch grooves, meschart grooves, chevron grooves, contribution of angle and pitch on juice drainage, Calculation of Juice drainage area requirement.

MILL DRIVES, MILL GEARING AND MILL SPEED

Type-steam engines, steam turbines and electric motors- their merits and demerits. Combined and individual drives and hydraulic drives. Speed reduction, gear arrangement, types of gears used, type of couplings. Selection of speed, sequence of speed and effect on crushing rate, power consumption. reabsorption factor etc.

POWER REQUIREMENT OF MILLS: Power absorbed by compression, friction, journal and bearing, bagasse and trash plate, scrappers and roller, Intermediate carriers, gearing, general formula, factors affecting power consumption in a mill..

MILL SETTING: Calculation of mill settings by different methods, mill ratio, roller lift, setting at rest, effect of fibre loading, imbibition and cane preparation on mill setting.

PRIME MOVERS: Estimation of power requirement, steam consumption of prime movers-steam turbines(single and multistage), steam engines (drop valves, corollas, valve, piston valve and D – slide valves), effect of inlet pressure, superheat and exhaust pressure on steam consumption.

FINE BAGASSE SEPARATORS

Different types of separators-stationary screens and drag type conveyors, vibrating screens, D.S.M.screens, rotary screens, their application, advantages and disadvantages.

DIFFUSER Types of diffusers-Moving Screen, Static Screen, Reciprocating Screen diffusers - their description, retention time, power and steam requirement, capacity, automatic controls, treatment of their juices, their merits and demerits.

PROCESS STEAM GENERATION INCLUDING ECONOMY MEASURES

Estimation of steam requirement at juice heaters, evaporators and pans. Steam balance of sugar factory-calculations. General steam distribution system in sugar factory, balancing between exhaust consumption and generation.

COGENERATION:

Definition and Types. Calculation of Power generation and Export. Different modes of Cogeneration. Economy of Fuel efficiency in Cogeneration. Effect of Steam inlet conditions on Cogeneration of Power.

HEAT CONSERVATION, ENERGY AUDIT AND MANAGEMENT

Lagging, heat loss from bare surface, properties and choice of lagging materials, saving due to lagging. Steam traps-different type including pumping sets, Condensate collection systems-different systems, their limitations, merits and demerits, waste heat recovery..

GEAR DESIGN

H.P. rating calculation for gears as per Indian Standard code, basic of gear design and gear transmission system design.

Reference Books—1.Machinery & Equipments of Cane Sugar Factory by L.A. Tromp, Twentieth Century pub.,New Delhi
2. Hand Book of Cane Sugar Engineering by E. Hugot, Elsevier Pub. Co. Ltd.,New York

SUBJECT : EQUIPMENT DESIGN & GENERAL ENGINEERING

CODE : SE/207 A MAX. MARKS : 50

EQUIPMENT DESIGN

1. Material of construction & properties : General considerations, Ferrous & Non Ferrous metals, Properties at low and high temperatures.
2. Vessel Design: Open vessels-horizontal & vertical – flat bottom, semi-cylindrical, conical bottom & dished. Closed Vessels-vertical & horizontal. Vessels subjected to internal pressures and external pressures. Optimum tank proportions, stress analysis of tanks – shell thickness calculations. Reinforcement of shell courses, reinforcement of openings. Roof design – self supporting conical roof & structural supported conical roofs. Common types of formed heads & their selections, stress analysis of heads.
3. Design of supports – supports for horizontal & vertical vessels.

SUBJECT: EQUIPMENT DESIGN &GENERAL ENGINEERING

CODE : SE/207 B MAX. MARKS : 50

GENERAL ENGINEERING

1. **Engineering flow sheets-** Computation of mass and energy balances. Preparation of process flow diagrams and P & I diagrams for mill and boiling house.
2. **Design and rating of sugar process equipments-** Fired and unfired exchangers- heaters, pre-heaters, economizers, super heaters and condensers and jet ejection and cooling Towers. Equipment specification sheets.

Reference Books— 1.Computer Aided Degines in Mechanical Engineering
by V. Ramamurthy,Tata McGraw Hill Pub. Co.Ltd., New Delhi
2.Hand Book of Cane Sugar Engineering by E. Hugot, Elaevier Pub. Co., New York
3. Chemical Engineering Vol.6 (Coulson Richesdson)

SUBJECT : ELECTRICAL ENGINEERING
CODE : SE/208 MAX. MARKS : 100

1. **Synchronous Generator:** Principle of operation of synchronous generator, Construction features of synchronous generator, Excitation system of synchronous generator, Classification of synchronous generator, Power equations of synchronous generator, Voltage regulation, OC & SC tests of synchronous generator, Short circuit ratio of synchronous generator, Parallel operating conditions of synchronous generator, Applications of synchronous generators
2. **Insulated Cables:** Construction features of insulated cables, Calculation of insulation resistance, capacitance and dielectric stress of cables, Choice of cable sizes for different applications, Introduction of various types of switch gears (switches, circuit breakers, fuses, relays etc.) used in sugar industry.
3. An integrated study of power system of sugar factory: Power generation, transmission and its utilization, Concept of co-generation system in sugar industry, Switch yard arrangement, Concept of harmonics, its effect on power quality & its mitigation techniques.
4. Various types of electrical motors used in sugar factory with justification for various stations, in particular, to cane unloaders, cane preparations, cane carriers, cane milling, boiler applications, boiling house applications etc.
5. Measures to reduce total captive power consumption in sugar industry to 22 KWh/MT cane for electrical drive system.

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 : DRAWING & DESIGN
CODE : SE/209 MAX. MARKS : 100

1. **MILL: (a) THEORY:**
Design of pressure feeding devices – under feeders: grooved and toothed type, Donnelly chute with under feeder, G.R.P.F and T.R.P.F.
- (b) **PRACTICAL :**
 - i. Drawing of Donnelly chute with under-feeder.
 - ii. Drawing of continuous pressure feeder.
2. **PAN: (a) THEORY:**
Types : Batch and Continuous Pan. Functional and constructional details, Material of construction and its properties, design parameters, Graining volume, Hydrostatic head, Circulation ratio, Diameter and length of tube. Determination of heating surface, Number of tubes, Diameter of tube plate, Diameter of downtake. Calculation of graining volume, Hydrostatic head, Vapour space, Thickness of calendria shell, Thickness of tube plate, Thickness of body. Calculation of vapour, condensate, syrup, non condensable gases, cutover, washout lines. Design of save – all.
- (b) **PRACTICAL :(i) Drawing of General Arrangement,**
(ii) Drawing of tube plate. (iii) Drawing of save-all.
3. **CONDENSER :**
- (A) **THEORY:**

Functional and constructional details of Multijet condensers.

i. Multijet Condenser:

Types: 1. Separate spray & jet nozzle box. 2. Combined spray & jet nozzle box.

Calculation of diameter and height of condenser, quantity of injection water in spray and jet nozzles, number and size of spray and jet nozzles, diameter of main injection water line, spray box line and jet box line and tail pipe diameter.

ii. Cooling Towers- Psychometric chart, calculation of make up water.

(B) PRACTICAL:

i. Drawing of Multijet condenser. ii. Drawing of Cooling Tower shells.

4. CRYSTALLIZER:

(a) THEORY:

Functional and Constructional details, material of construction, determination of length, width and depth of air cooled and water cooled crystallizers. Batch. & Continuous crystallizers (horizontal & vertical). Calculation of cooling surface for air cooled and water cooled crystallizers. Calculation of shell thickness and side plate thickness, number of cooling elements, size and pitch.

(b) PRACTICAL : Practice on Computer Aided Drafting & Designing in Auto Cad Lab.

(i) Drawing of air cooled crystallizers. (ii) Drawing of water cooled crystallizers.

5. CENTRIFUGAL MACHINES:

Design of batch type centrifugal machine basket.

Reference Books-Computer Aided Design in Mechanical Engineering
by V. Ramamurthy, Tata Mc Graw Hill Pub. Co. Ltd., New Delhi

SUBJECT : INSTRUMENTATION

CODE : SE/210 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, I/P Converter, Electro pneumatic positioner**, Electronic controller.

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, boiler control & process house control loop.

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. Industrial Instrumentation & Control (C.S.Rao)

4. Process control Instrumentation Technology by Curtis D. Johnson, Pearson Publication.

SUBJECT : SUGAR TECHNOLOGY (PRACTICAL)

CODE : SE/212 MAX. MARKS : 50

1. Determination of total soluble solids by

(a) Brix spindle.

(b) Refractometer.

2. Determination of pol and calculation of apparent purities in juice, syrups and other boiling house products.

3. Determination of sucrose and calculation of gravity purity in juices and other boiling house products by Jackson & Gills method.

4. Determination of reducing sugars in juice, syrups and molasses by Eynon and Lane method.

5. Determination of Preparatory Index of the prepared cane.

6. Determination of pH of various cane sugar products by pH meter.

7. Preparation of solutions and determination of sugar traces in condensate, condenser water and boiler feed water by alpha naphthol method.
8. Analysis of bagasse for moisture % and pol%.
9. Analysis of Boiler feed water for pH, hardness and alkalinity etc.

Reference Books- System of Technical Control by N. C. Verma, S.T.A.I., New Delhi