

UNIVERSITY DEPARTMENTS
ANNA UNIVERSITY CHENNAI : : CHENNAI 600 025
REGULATIONS - 2009
CURRICULUM I TO IV SEMESTERS (FULL TIME)
M.TECH SUGAR ENGINEERING

SEMESTER I

| SL. NO | COURSE CODE | COURSE TITLE | L | T | P | C |
|----------------------|-------------|--|-----------|----------|----------|-----------|
| THEORY | | | | | | |
| 1. | SU9111 | Heat and Mass Transfer | 3 | 1 | 0 | 4 |
| 2. | SU9112 | Milling | 3 | 0 | 0 | 3 |
| 3. | SU9113 | Process Control and Instrumentation | 3 | 0 | 0 | 3 |
| 4. | SU9114 | Sugar Process Calculation and Solid Balance | 3 | 0 | 0 | 3 |
| 5. | SU9115 | Sugar Technology – Clarification and Evaporation | 3 | 0 | 0 | 3 |
| 6. | E1 | Elective I | 3 | 0 | 0 | 3 |
| PRACTICAL | | | | | | |
| 7. | SU9117 | Chemical Engineering Lab | 0 | 0 | 3 | 2 |
| | SU9118 | Seminar | 0 | 0 | 2 | 1 |
| TOTAL CREDITS | | | 18 | 1 | 3 | 22 |

SEMESTER II

| SL. NO | COURSE CODE | COURSE TITLE | L | T | P | C |
|----------------------|-------------|--|----------|----------|-----------|-----------|
| PRACTICAL | | | | | | |
| 1. | SU9121 | Project Work (Phase I) | 0 | 0 | 24 | 12 |
| TOTAL CREDITS | | | 0 | 0 | 24 | 12 |

SEMESTER III

| SL. NO | COURSE CODE | COURSE TITLE | L | T | P | C |
|----------------------|-------------|---|-----------|----------|----------|-----------|
| THEORY | | | | | | |
| 1. | SU9131 | Sugar Machinery Design | 3 | 0 | 0 | 3 |
| 2. | SU9132 | Capacity Calculations | 3 | 0 | 0 | 3 |
| 3. | SU9133 | Mechanical and Electrical Machineries | 3 | 0 | 0 | 3 |
| 4. | SU9134 | Pan Boiling, Curing and By Products | 3 | 0 | 0 | 3 |
| 5. | E5 | Elective II | 3 | 0 | 0 | 3 |
| PRACTICAL | | | | | | |
| 6. | SU9136 | Sugar Technology Lab | 0 | 0 | 3 | 2 |
| 7. | SU9137 | Heat and Mass Transfer Lab | 0 | 0 | 3 | 2 |
| TOTAL CREDITS | | | 15 | 0 | 6 | 19 |

SEMESTER IV

| SL. NO | COURSE CODE | COURSE TITLE | L | T | P | C |
|----------------------|-------------|---|----------|----------|-----------|-----------|
| PRACTICAL | | | | | | |
| 1. | SU9141 | Project Work (Phase II) | 0 | 0 | 24 | 12 |
| TOTAL CREDITS | | | 0 | 0 | 24 | 12 |

TOTAL CREDITS TO BE EARNED FOR THE AWARD THE DEGREE = 65

LIST OF ELECTIVES

| SL. NO | COURSE CODE | COURSE TITLE | L | T | P | C |
|--------|-------------|---|---|---|---|---|
| 1. | SU9151 | Food Process Engineering and Technology | 3 | 0 | 0 | 3 |
| 2. | SU9152 | Modern Separation Process | 3 | 0 | 0 | 3 |
| 3. | CR9156 | Safety Engineering | 3 | 0 | 0 | 3 |
| 4. | SU9154 | Sugar Agriculture | 3 | 0 | 0 | 3 |
| 5. | SU9155 | Statistical Analysis | 3 | 0 | 0 | 3 |
| 6. | SU9156 | Energy Engineering | 3 | 0 | 0 | 3 |

SU 9111

HEAT AND MASS TRANSFER

L T P C
3 1 0 4

UNIT I **9**

Flow of heat - different modes of heat transfer - heat transfer through compound resistances - heat transfer through fluids – Laws of thermal radiation - Newton's Law of Cooling - Heat transfer equipment - different types of heat exchangers - different types of evaporators - Multiple effect evaporator - Calculations.

UNIT II **9**

Mass Transfer: Theory of Mass Transfer - Derivation of Mass transfer equations - Extraction - various equipment for extraction - Theory of separations- Solid/Solid separation- Solid liquid separation - Liquid/liquid separation - Setting - Filtration, centrifuging - Theory - Various equipments - Theory of setting - Theory of filtration - Theory of Centrifuging - Various equipment - Membrane Separations.

UNIT III **9**

Mixing and agitation - Various mixing equipment- Theory - Power consumption formula.

UNIT IV **9**

Gas absorption & drying - Theory of gas absorption - Humidity - Relative humidity - Theory of drying - various drying equipments.

UNIT V **9**

Crystallization: Solution - Solubility – Super saturation - Mier's Theory of Crystallization - Rate of crystallization – Various equipment for crystallization - Various methods of crystallization - Cake formation.

L : 45 , T : 15 , TOTAL : 60 PERIODS

REFERENCES

1. J.M Coulson and J.F. Richardson "Chemical Engineering"Vol.2.,Third Edition. Pergamon Press, 1977.
2. W.L. McCabe and J.C.Smith,"Unit Operation in Chemical Engineering," McGraw Hill Kogakusha, 1976.
3. R.E. Treybal, "Mass Transfer Operations,"McGraw Hill Kogakusha, 1976
4. T.K.Sherwood, R.L.Pigford and C.R.Wilha,"Mass Transfer,"McGrawHill 1976.

SU 9112

MILLING

L T P C
3 0 0 3

UNIT I **5**

Cane Handling - Different types of cane unloader - Merits and Demerits.

UNIT II **5**

Cane Carrier - Construction - Slope - Drive - Length - Speed –Width - Power consumption - Split Cane Carrier - Automisation.

UNIT III **5**

Cane Preparation - Aim - Different types of preparatory devices and drive - Their merits and demerits - power consumption.

UNIT IV **15**
 Milling- Millcapacity- Mill- setting- Milling Efficiency Different types of Mill drive - Trash - plate setting - Bearing - Pinion – Scrapers - Roller grooving - Different types of Mills housing.

UNIT V **15**
 Hydraulic pressure - Different types Hydraulic loading – specific loading - Different types of pressure feeding - Mills speed – Imbibition - Different types - Factors affecting Milling capacity and Efficiency - Inter Carriers - Different types - Power Consumption - Low cost - milling - Diffuser.

TOTAL : 45 PERIODS

REFERENCES

1. E. Hugot, Hand Book of Cane Sugar Engineering' III Completely Revised Edited, Elsevier Publications, New York 1986.
2. Tromp (L.A) 'Machinery and Equipment of Cane Sugar Factory' Twentieth Century Publications, New Delhi, 1946.
3. Murry (C.R) & 'Machinery and Crushing Sugar Cane', Elsevier Publications, New York, 1967.
4. Chen 'Cane Sugar Hand Book', John Wiley & Sons, New York, 1985.

SU 9113 **PROCESS CONTROL AND INSTRUMENTATION** **L T P C**
3 0 0 3

UNIT I **13**
 Introduction to instrumentation - Terminology - Transducers Indicator- Recorder – Controller Pressure and Vacuum Gauges - Different types of Manometers - Elastic devices, Construction, theory and working – Calibration - Dead weight tester - Diaphragm type - Bellows - Draft gauge - Thermometers - Liquid, Gas and Vapour filled thermometers – Temperature correction - Bimetallic thermometers - Principle, Construction & Working of thermocouples - Flow Measurement: Orifice meter - Venturimeter - Rotameter – Magnetic flowmeter - Construction, Working and design.

UNIT II **9**
 Level measurement - Differential pressure - Ultrasonic, Optical methods.

UNIT III **9**
 Analytical Instruments: Conductivity meter - pH meter – Moisture meter – Gas Analyser.

UNIT IV **10**
 Controls - on/off controller - Proportional controller PID controller - Programmable controller - Direct Digital controllers – Supervisory control - Distributed control - Control valves Temperature and Pressure control systems for sugar industry - Application - Instruments Electronics used in Sugar Industry, Boilers and pans.

UNIT V**4**

Fully Automation of Sugar Industry.

TOTAL : 45 PERIODS**REFERENCES**

1. Coughanour and Koppel, "Process System analysis and control", McGraw Hill, New York.
2. P.Harriot,"ProcessControl",TataMcGraw Hill, New Delhi, 1997.

SU 9114 SUGAR PROCESS CALCULATION AND SOLID BALANCE L T P C
3 0 0 3

UNIT I**9**

Terminology , Pol % Cane, Mill Extraction, Reduced Mill Extraction, Milling Loss, Whole Reduced Extraction.

UNIT II**9**

Imbibition % Fibre , Overall Extraction , Reduced Overall Extraction , Primary Extraction, Secondary Extraction based on simple and compound Imbibition.

UNIT III**9**

Brix Curve, Individual Mill Extraction , Individual Mill Efficiency.Boiling House Recovery , Boiling House Loss, Virtual Purity of final Molasses , Reduced Boiling House Recovery.

UNIT IV**9**

ERQV, SG,ESG, Recovery in terms of ESG , Basic Boiling House Recovery, Boiling House Performance.Pol Balance, Brix Balance , Non Sugar Balance, Water Balance.

UNIT V**9**

Brix Free Cane Water, Java Ratio, Winters formula , Stock Taking.Solids Balance For A-Footing, A- Masecuite , C- Grain , C- Masecuite, B- Grain , B- Masecuite, C-Masecuite Fore Curing, C- Fore Curing , B- Masecuite Double Curing, A- Masecuite Curing.R.T.7(C) , R.T.8(C).

TOTAL : 45 PERIODS**REFERENCES**

1. Hand Book of Cane Sugar Engineering by E.Hugot.
2. Principles of Sugar Technology by P.Honig.

SU 9115 SUGAR TECHNOLOGY CLARIFICATION AND EVAPORATION L T P C
3 0 0 3

UNIT I 9

Composition of cane and cane juice, Aim of clarification , clarification efficiency. Cabonation process, Double sulphitation process, Phosphitation Process.

UNIT II 9

Various juice heaters, Various clarifiers , Vacuum Filters.Milk of lime preparation , Sulphur burner and preparation of SO2 Gas.

UNIT III 9

Juice Sulphitation , Syrup Sulphitation , Use of different chemicals.Aim of evaporation, Different types of evaporators, Different types of vapour bleeding System , Steam economy , DEVC cum Quad System, Quintuple System.

UNIT IV 9

Scale formation, De scaling, Cleaning procedure.Different types of condensers, Condensates, Ammonia gas, Entrainment, Save all.

UNIT V 9

Syrup / Melt Clarification , Filtrate Clarification.

TOTAL : 45 PERIODS

REFERENCES

1. Principles of Sugar Technology by P. Honig.
2. Hand Book of Sugar Technology by R.B.L. Mathur.
3. Hand Book of Cane Sugar Engineering by E. Hugot.
4. Cane Sugar Hand Book by Meade And Chen.
5. Introduction To Cane Sugar Technology by G.H. Jenkin

SU 9117 CHEMICAL ENGINEERING LABORATORY L T P C
0 0 3 2

1. Calibration of Venturimeter
2. Calibration of Orifice meter
3. Pressure drop studies in pipeline
4. Characteristics of Centrifugal Pumps
5. Flow through porous bed
6. Crushing Rolls and Ball Mill
7. Leaf Filter
8. Sieve analysis and effectiveness of Sieving
9. Sedimentation

TOTAL : 45 PERIODS

SU9118 SEMINAR L T P C
0 0 2 1

Students are expected to present two seminars along with report on any recent topic in chemical engineering.

| | | |
|--|-------------------------------|----------------------------------|
| SU 9131 | SUGAR MACHINERY DESIGN | L T P C 3 0 0 3 |
| UNIT I | | 9 |
| Site Selection, Machinery lay out, General Design. | | |
| UNIT II | | 9 |
| Methods of fabrication, Design procedures , Material of construction and properties , Design and corrosion control, Vessel Design, Design of supports. | | |
| UNIT III | | 9 |
| Trash plate profile. Juice Heaters , Juice Sulphitors, Clarifiers. Evaporators , Syrup Sulphitors. Pans(Batch/ Continuous). | | |
| UNIT IV | | 9 |
| Molasses conditioners , Melters, Syrup/ Melt clarifiers, Filtrate clarifier. Crystallisers (Seed , Vacuum, Air/ Water cooled, Vertical). | | |
| UNIT V | | 9 |
| Condensers and common Headers, Molasses tanks, Spray pond , Work shop Machinery. | | |
| | | TOTAL : 45 PERIODS |

REFERENCES

1. Hand Book of Cane Sugar Engineering by E. Hugot.
2. Machinery And Equipment of Cane Sugar Factory by L.A. Tromp.
3. Chemical Engineering Hand Book by J.H.Perry .
4. Mechanics of Crushing Sugarcane by C.R. Murry.

| | | |
|--|------------------------------|----------------------------------|
| SU 9132 | CAPACITY CALCULATIONS | L T P C 3 0 0 3 |
| UNIT I | | 5 |
| MILLING: Unloader , Cane Carrier , Preparatory devices, Mills size , Inter/ Rake carrier , RBC, power requirement , diffuser. | | |
| UNIT II | | 15 |
| BOILERS: Boiler , Gate Area , Combustion chamber, ID, FD, Chimney , Possibility for maximum export of power to suit crushing rate. CLARIFICATION: Juice flow meter , juice sulphitation vessel, sulphur burner, lime slacker and lime tanks, flask tank, clarifier, vacuum filter, juice heaters, condensate pumps, ammonia lines, juice pumps , air compressor. EVAPORATORS: Heating surface, Vapour line dia , Condensers, condensate pumps, ammonia lines , steam requirement, steam economy , syrup sulphitor. | | |
| UNIT III | | 10 |
| PANS: No. of Pans, heating surface , vapour line Dia , Molasses conditioners, supply tanks, continuous pans. CRYSTALLISERS: Vacuum crystallisers, water/ air cooled crystallisers, vertical crytalliser, hot and cold water tanks. | | |

UNIT IV **5**
COOLING AND CONDENSING: Injection pumps and water requirement , spray pond , capacity, pumps, common header, condensers.

UNIT V **10**
CENTRIFUGALS: No. of centrifugals, gravity factor, super heaters, hopper, grader, hot and cold air blowers, sugar elevator, sugar bin.
GENERAL: Water requirement , sugar godown, molasses tanks, ETP.

TOTAL : 45 PERIODS

REFERENCES

1. Hand Book of Sugar Technology by R.B.L. Mathur.
2. Hand Book of Cane Sugar Engineering by E. Hugot.
3. Machinery and Equipment of Cane Sugar Factory by L.A. Tromp.

SU 9133 **MECHANICAL AND ELECTRICAL MACHINERIES** **L T P C**
3 0 0 3

UNIT I **9**
Applied Thrmodynamics - Law of perfect gases - PV diagrams - Carnot cycle - Reversible, irreversible cycles - Otto cycle - Diesel cycle.

UNIT II **9**
Air Compressors - Different types of Compressors - Cycles - Power Consumption - efficiency.

UNIT III **9**
Steam turbines - Different types of turbines including Double Extration, Condensing Turbines - Stopping & Starting of Turbines, Vibration - Fundamental Analysis - Influence - Calculation of blade angle - steam consumption.

UNIT IV **9**
Pumps - different types - Uses – Maintenance.

UNIT V **9**
Electrical Machinery & Power: Resistors - DC circuits - Inductors and Capacitors - AC Circuits - Power and Power Factor - DC Generators - DC Motors - Starters - AC Motors - Starters - Transformers - Cogeneration - Energy Audit.

TOTAL : 45 PERIODS

REFERENCES

1. H.Cotton, "Electrical Technology. "Pitman Publications, 1965.
2. Uppal, "Text Book of Electrical Engineering," Khanna Publishers, 1965.
3. B.L.Theraja, "Text Book of Electrical Technology, "Niraj Publishers, 1970.
4. Smith J.M. and VanNess H.C. "Introduction to Chemical Engineering Thermodynamics, "Kogakusha, 1976
5. Dodge B.F. "Chemical Engineering Thermodynamics", McGraw Hill, 1960.
6. S.H.YAHYA "Turbines, Compressors and fans, "Tata McGraw Hill Publishers Co., Ltd. New Delhi 1983.

SU 9134

PAN BOILING, CURING AND BY PRODUCTS

L T P C

3 0 0 3

UNIT I

9

Aim of crystallization , different types of massecuite boiling supply tanks, molasses conditioner, vacuum crystallisers.S/V ratio, boiling point elevation, hydrostatic head , massecuite circulation.Super saturation co-efficient, different super saturation zones.

UNIT II

9

Slurry preparation, true seeding.Raw sugar boiling , refined sugar boiling.Scaling , cleaning procedure.

UNIT III

9

Treatment of massecuite by air and water cooling , vertical crystalliers for B and C – massecuite. Batch centrifugals, continuous centrifugals, curing of different massecuite , liners for different machines, molasses separators , different types of lubrication , super heated wash water, pug mill , run off tanks , magma minglers, melters, use of srrop for affinitation and melters.

UNIT IV

9

Gross hoper , hot air blower , cold air blower, sugar elevator, sugar grader, sugar bin , sugar bagging, sugar storage in the godown.Sugar beet, sweet sorghum, carbon credit.

UNIT V

9

Composition of bagasse and its uses, composition of final molasses uses, composition of filter cake and its uses, composition of tops, trash and its uses, composition of boiler ash and its uses.Ethanol from sugar house products.

TOTAL : 45 PERIODS

REFERENCES

1. Cane Sugar Hand Book by Spence & Meade .
2. Principles of Sugar Technology by P. Honig.
3. By Products of Cane Sugar Industries by Patturau.
4. Hand Book of Sugar Technology by R.B.L. Mathur.
5. Hand Book of Cane Sugar Engineering by E. Hugot.
6. Cane Sugar Hand Book by Meade and Chen.
7. Introduction to Cane Sugar Technology by G.H. Jenkin.

SU 9136

SUGAR TECHNOLOGY LABORATORY

L T P C

0 0 3 2

1. Brix by brix hydrometers , brix by hand refractometers , Brix , Pol and purity of juices , massecuites and molasses.
2. Pol% bagasses, moisture % bagasse, preparatory index.
3. Sucrose by double polarization.
4. Pol% sugar , moisture % sugar, ash % sugar.
5. Phosphate in juice , calcium oxide in juice, glucose ash ratio.
6. Total exhaustion, crystal % massecuite.
7. Boiler water analysis for pH, TDS , Hardness.
8. Crystal size- Total Reducing sugar- available sugar.

9. Sulphur Di Oxide content in sugar , safety factor.
10. ICUMSA in sugar and juices , massecuites and molasses.
11. Dextran and starch in sugar house materials.

TOTAL : 45 PERIODS

REFERENCES

1. System of Technical Control For Cane Sugar Factories In India - 2005 by N.C. Verma.
2. Hand Book of Sugar Technology by R.B.L. Mathur.
3. Hand Book of Cane Sugar Engineering by E. Hugot.
4. Text Book of Qualitative Analysis by Vogel.
5. Cane Sugar Factory Control by Banerji.

SU 9137

HEAT AND MASS TRANSFER LABORATORY

L T P C

0 0 3 2

1. Liquid heat transfer
2. Cooling tower
3. Crystallisation
4. Wetted wall column
5. Pan dryer
6. Jacketed Pan
7. Film evaporator
8. Diffusivity measurement

TOTAL : 45 PERIODS

**SU 9151 FOOD PROCESS ENGINEERING AND TECHNOLOGY L T P C
3 0 0 3**

UNIT I CONSTITUENTS OF FOODS 9
Carbohydrates-proteins, Lipids, Vitamins, Additives, Preservatives, Solvents, Flavours, Agents, Food Engineering operations, Food sorting, Cleaning, Grading-harvesting-winnowing-drying-storage-prime processing.

UNIT II FOOD ENGINEERING PROCESS OPERATIONS 10
Materials and Energy Balances-Fluid flow applications, Heat transfer applications - Drying Evaporation, Equilibrium stage process, Soxhlet extractions, Applications Mechanical separations, Mixing, Applications, Dairy, Meat Industry Oil and Flat Industry Cereal processing.

UNIT III PRESERVATION OPERATIONS 9
Preservation methods & Strategies, Thermal Methods, Nabla Factor Sterilisation Types Pasteurisation Dehydro freezing Irradiation Dosimetry Transport of food & Preservation strategies Cheap and applicable everywhere.

UNIT IV PLANT HYGIENE 7
Plant Hygiene Design Sterilisation Process water quantity upkeep waste disposal Material handling, packaging of solid liquid foods, Food storage, special case studies.

UNIT V DEVELOPMENT IN FOOD PROCESSING 10
Developments in Food Processing Pruteen Food for future, Food constituents and processing Food emulsions food Rheology Advances in thermal Operation Extrusion, cooking Spary dryer design, Energy expenditure & saving Food, for developing countries, Food Detoxification, Production of Sweeteners, starch, Microbial Polysaccharides, Aminoacid, Ricebran Tocopherols. Quality control in food industry, Dose response relationship, Health Problems, Chemical and Micro biological aspects, Food analysis, Instruments and Enzymatic analysis, Food safety.

TOTAL : 45 PERIODS

REFERENCES

1. Jowitt R (Ed) - " Hygienic Design and operation of Food Plant", AVI Pvt. Co. Westort (1980). '
2. Head man D.R & RP.Singh - " Processing ", AVI Pvt. Co., West Port (1981).
3. Brennan.J., GI Rbutters, N.D.Cowell &AEV Lily-(ED) -" Food Engineering GtJerations III Ed ", Applied Sc Publishers London. UK (1990).
4. Muller H.G. " An introductiQn to tropical Food Science ", Cambridge Univ Press, New York (1998).
5. Proceedings of the 6th International Congress in Food Sc and Technology, Dublin Ireland (1983) Vol. 1,4 & 5.
6. Bourne.E.M. " Food Texture and Measurement of viscosity", Academic press New york,U.S.A, (1982).
7. R.L.Earle" Unit operations in Food Processing ", pergemmon Press, Oxford, UK (1990) Reprint.

UNIT I GENERAL 12

Review of conventional processes, Recent advances in separation techniques based on size, surface properties, ionic properties and other special characteristics of substances, Process concept, Theory and equipment used in cross flow filtration, cross flow electrofiltration, dual functional filter, Surface based solid -liquid separations involving a second liquid, Siroflocfilter.

UNIT II MEMBRANCE SEPARATIONS 8

Types and choice of membranes, Plate and frame, tubular, spiral wound and hollow fibre membrane reactors and their relative merits, Commercial, pilot plant and laboratory membrane permeators involving dialysis, reverse osmosis, Nanofiltration, ultrafiltration, Microfiltration and Donnan dialysis, Economics of membrane operations, Ceramic membranes.

UNIT III SEPARATION BY ADSORPTION TECHNIQUES 8

Mechanism, Types and choice of adsorbents, Normal adsorption techniques, Affinity chromatography and immuno chromatography. Types of equipment and commercial processes, Recent advances and process economics.

UNIT IV IONIC SEPARATIONS, 8

Controlling factors, Applications, Types of equipment employed for electrophoresis, Dielectrophoresis, Ion exchange chromatography and electro dialysis, Commercial Processes.

UNIT V OTHER TECHNIQUES 9

Separations involving lyophilisation, Pre evaporation and permeation techniques for solids, liquids and gases. Industrial viability and examples, Zone melting, Adductive crystallization, Other separation process, Supercritical fluid extraction, Oil spill Management, Industrialeffluent treatment by modern techniques.

TOTAL : 45 PERIODS**REFERENCES**

1. Lacey, R.E . and S.Loeb - " Industrial Processing with Membrances ", Wiley - Inter Science, New York, 1972.
2. King, C.J. " Separation Processes ", Tata McGraw – Hill Publishing Co., Ltd., 1982.
3. Schoew, H.M. - " New Chemical Engineering Separation Techniques ", Interscience Publishers, 1972.
4. Ronald W.Roussel - " Handbook of Separation Process Technology", John Wiley, New York, 1987.
5. Kestory, R.E. - " Synthetic polymeric membranes ", Wiley, New York, 1987.
6. Osadar, Varid Nakagawa I - " Membrane Science and Technology", Marcel Dekkar (1992).

AIM

The course is aimed to impart basic knowledge about hazards, its effects, safety and waste management together with risk analysis.

OBJECTIVES

On completion of the course the students are expected to

- Have a basic understanding about hazard identification and checks for safety.
- Have learnt about various waste management techniques.
- Have basic knowledge about risk analysis, format and methods.

UNIT I GENERAL 9

Safety - total definition - hazard identification, general hazards of plant operation, toxic hazards, fire & explosions – hazards transport of chemicals with safety unforeseen deviations emergency management, planning for safety, selecting basis of safety preventive and protective measures, safety based on emergency, relief systems, safety based on containment, operational safety procedural instructions Sla-routine checks, process and product charges, safety checks, checklist for safety, leaks and detection.

UNIT II HAZARDS AND EFFECTS 9

Hazards of plant operation, toxic hazards, fire and explosion hazards, reaction hazards, literature calculations & explosions screening, normal reaction, gas evolution, characterizing runaways, control and mitigation of gas emanations, absorption with chemical reaction, health and environ effects.

special problem of developing countries, safety gadgets, dispersions, degree of hazard, disposals, hierarchy of options, I.C.A. application, nil hazards & alternate methods, threshold limits, laws of safety, accident reporting.

UNIT III ACCIDENT REPORTING INVESTIGATION AND DOCUMENTATION 9

Reporting an accident – selling up closed loop reporting system – Automated system – Forming an investigation board – Conducting an investigation – investigation report – Documenting the accident – Retention of records – Public release of information

UNIT IV WASTE MANAGEMENT AND ECONOMICS 9

Storage, central handling safety, unintentional spills, run offs emits, containment economics, waste disposal and environmental projection, incineration, alternatives.

UNIT V RISK ANALYSIS 9

Risk analysis, evaluation, mitigation, hazop, hazan, definition, probability, quantification-risk, engineering, clean technology, initiatives, standards, emergency handling, accident investigation, legislation, nil risk quantification methods, case histories of accidents, examples of hazards assessment, examples of use of hazan, explosion hazards in batch units, technical process, documentation for hazardous chemicals, format and methods.

TOTAL: 45 PERIODS

REFERENCES

1. Rohatga.A.K. Safety Handling of Hazardous Chemicals Enterprises, Bombay (1986).
2. Shukla.S.K.-Enviro Hazards and Techno Legal Aspects, Shashi Publications, Jaipur-India(1993).
3. Wells G.L. and R.M.C.Seagrave –Flow Sheeting for Safety, I.Ch.E.London, U.K.(1977).
4. Learning from Accidents- Trevur Kletz Butterworths London U.K.(1988).

5. Chemical Reaction Hazards – A Guide to Safety, Institution of Chemical Engineering London U.K. Ed by John Barton and Richards Rogers (1997).

| | | |
|---|--------------------------|----------------|
| SU 9154 | SUGAR AGRICULTURE | L T P C |
| | | 3 0 0 3 |
| UNIT I | | 9 |
| Sugar producing plants. History, Origin and Distribution of Sugarcane-Major Sugarcane Producing countries in the world. Area under Sugarcane in Different states of India. Cultivation of Sugarcane: Brief lectures on soils types, preparation of land, periods of sowing, cane seed, methods of planting, optimum conditions for germinations, tillering growth and maturity of the crop. | | |
| UNIT II | | 9 |
| Nutrition of Sugarcane - Nitrogen, Phosphorous and potash – Effect of each element on tonnage and sugar content: A lecture on the role of micronutrients in sugarcane. | | |
| UNIT III | | 9 |
| Plant protection Measures for Sugarcane - Major diseases and pests - symptoms, period of occurrence, control measures and effect on yield and sugar content -Harvesting and Transport Management - Method for testing - maturity of sugarcane - Advantages of harvesting sugarcane on the basis of Pre-harvest Maturity test. | | |
| UNIT IV | | 9 |
| Sugarcane Varieties. Deterioration of Sugarcane - Factors affecting deterioration and control measures. Effect on deterioration of cane on weight and sugar content. | | |
| UNIT V | | 9 |
| Burnf cane - Effect on weight and sugar content.Sugar Beet - A brief lecture on requirement of the crop and potentialities for growing in India.Cultivation of sugar beet and Sweet-Sorghum, methods and period of sowing, fertilization and maturity.Comparison of sugarcane and sugar beet for production sugar in India. | | |

TOTAL: 45 PERIODS

REFERENCES

1. Mathur, 'Hand Book of Cane Sugar Technology, Oxford And I.B.H. Publishing Co., New Delhi 1975:S.v.Parthasarathy" -Sugar cane cultivation in India.
2. E.Hugot, 'Hand Book of Cane Sugar Engineering' III completely revised Edition, Elsevier Publications, New York, 1986. "S.v.Parthasarathy" - Sugar Cane cultivation in India

SU 9155

STATISTICAL ANALYSIS

**L T P C
3 0 0 3**

UNIT I ELEMENTARY PROBABILITY THEORY 9

Axioms of Probability-Conditional probability-total probability- Bayes theorem-random variables-discrete and continuous

UNIT II EMPIRICAL STATISTICS 9

Measures of Central tendency, dispersion, skewness and kurtosis - Principle of least squares - Correlation and regression - rank correlation.

UNIT III SAMPLING DISTRIBUTIONS AND ESTIMATION 9

Sampling distributions - Point and interval estimates for population proportions, mean and variance – Maximum likelihood estimate method - Method of moments, interpolation and extrapolation

UNIT IV TESTING OF HYPOTHESIS 9

Sampling distributions - Tests based on Normal, t, Chi-square and F distributions - Analysis of variance – oneway and two-way classifications.

UNIT V DESIGN OF EXPERIMENTS 9

Completely randomized design - Randomized block design - Latin square design - 2 power 2 factorial design.

TOTAL: 45 PERIODS

REFERENCES

1. Freund, J.E. and Miller, I.R., " Probability and Statistics for Engineers ", Prentice – Hall of India, 5th Edition, New Delhi, 1994.
2. Gupta, S.C. and Kapur, V.K., " Fundamentals of Mathematical Statistics ", Sultan Chand & Sons, New Delhi, 1999.
3. Taha, H.A., " Operations Research : An Introduction ", Prentice - Hall of India, 6th Edition, New Delhi, 1997.

SU 9156

ENERGY ENGINEERING

**L T P C
3 0 0 3**

UNIT I GENERAL 7

Energy Resources – Conventional – Non conventional, Energy Reserves and Depletion, non-renewable energy sources

UNIT II POWER GENERATION 12

Power generation by steam, Hydroelectric, Diesel oil, Nuclear fission and Natural gas, Co-generation of power. Selection of power generation process, Economical and technical efficiency of power generation, socio-economic factor affecting consumption of power by various methods, Design and safety of equipments

UNIT III ALTERNATIVE ENERGY 12

Renewable sources of energy, Thermal and power generation using water, wind, sea wave, solar energy, Geothermal and biomass utilization

UNIT IV ENERGY CONSUMPTION AND AUDIT 7
Energy consumption Demand pattern, energy planning – Short term and long term,
Energy recovery, various types of Energy audit – advantages

UNIT V ENERGY CONSERVATION 9
Sugar industries; conservation in unit operation such as separation; cooling tower;
drying; conservation applied to sugar refineries,; conservation using optimization
techniques.

TOTAL : 45 PERIODS

REFERENCES

1. Francis, W and M.C. Peter, "Fuels and fuel technology", Pergamon Press, 1980.
2. Nagpal, G.R, "Power Plant Engineering", Khanna Publishers, 1973
3. Rused, C. K., Elements of Energy Conservation , McGraw-Hill Book Co., 1985