RANI CHANNAMMA UNIVERSITY BELAGAVI

REVISED CURRICULUM FRAMEWORK FOR

UNDER GRADUATE COURSE

STRUCTURE & SYLLABUS OF BACHELOR OF SCIENCE

SUGAR SCIENCE AND TECHNOLOGY

1ST TO 2ND Semesters

w.e.f.

Academic Year 2024-25 and Onwards

Submitted by

Chairman,
Board of Studies (UG),
Bachelor of Science,
Rani Channamma University, Belagavi.

SEMESTER – I

Sl. No	Course code	Name of course	Teaching hours	Duration of Exam	Marks			Credits
					IA	Exam	Total	
1	AECC ENG	English	4	3	20	80	100	3
2	AECC KAN	Kannada	4	3	20	80	100	3
3	AECC HINDI	Hindi	4	3	20	80	100	
4	**DSC1 T**	**Sugar Processing–I: Clarification**	4	3	20	80	100	3
5	**DSC1 P**	**Sugar Processing–I**, Practical,	4	4	10	40	50	2
6	**DSC2 T**	**Sugar Cane Agriculture**	4	3	20	80	100	3
7	**DSC2 P**	**Sugar Cane Agriculture-** Practical	4	4	10	40	50	2
8	**DSC3 T**	**Chemistry – I,**	4	3	20	80	100	3
9	**DSC3 P**	**Chemistry Practical-I,**	4	4	10	40	50	2
10		**Compulsory-I**	2	2	10	40	50	2
							TOTAL	**23**

Total teaching hours per week: 36

Total credits in semester: 23

*Sugar Science & Technology – SST

T: Theory, P: Practical, CC/EA: Co-Curricular/Extension Activities, AECC: Ability Enhancement Compulsory Course

SEMESTER – II

Sl. No	Course code	Name of course	Teaching hours	Duration of Exam	Marks			Credits
					IA	Exam	Total	
1	AECC ENG	English	4	3	20	80	100	3
2	AECC KAN	Kannada	4	3	20	80	100	3
3	AECC HINDI	Hindi	4	3	20	80	100	
4	**DSC4 T**	**Sugar Processing– II: Evaporation**	4	3	20	80	100	3
5	**DSC4 P**	**Sugar Processing– II:** Practical,	4	4	10	40	50	2
6	**DSC5 T**	**Sugar Engineering-I** Milling and Boiler	4	3	20	80	100	3
7	**DSC5 P**	**Sugar Engineering-I,** Practical,	4	4	10	40	50	2
8	**DSC6 T**	**Chemistry – II,**	4	3	20	80	100	3
9	**DSC6 T**	**Chemistry Practical II,**	4	4	10	40	50	2
10		**Compulsory-II**	2	2	10	40	50	2
							TOTAL	**23**

Total teaching hours per week: 36

Total credits in semester: 23

*Sugar Science & Technology – SST

T: Theory, P: Practical, CC/EA: Co-Curricular/Extension Activities, AECC: Ability Enhancement Compulsory Course

SEMESTER I

Program Name	**BSc in Sugar Science & Technology**	Semester	**I**
Course title	**SUGAR PROCESSING–I: CLARIFICATION (Theory)**		
Course Code	**DSC 1-T**	No. of Credits	**03**
Contact hours	**60 Hours (4 Hours/ week)**	Duration of SEA/Exam	**3hours**
Formative Assessment Marks	**20**	Summative Assessment Marks	**80**

Unit – I **15 Hours**

Introduction: Brief introduction to sugar industry in Karnataka & India, outline of Sugar manufacturing by sugarcane & Sugarbeet. Composition of sugarcane & Juice. Introduction different unit operations of sugar manufacture and general outline of sugar factory. Definitions and concept of various terms used in sugar technology – Cane, Binding Material, Extraneous Matter, Pol, Brix, Recovery, Juice, Bagasse, Primary Juice, Secondary Juice, Maceration, Imbibition Water, Bagasse, General juice composition, Clarification- objectives, types, significance.

Juice Clarification: basic concept of juice clarification, importance of juice clarification. Juice screening: importance, construction & working of different equipments used for juice screening.

Unit – II **15 Hours**

Juice weighment: Construction and working of Maxwell Boulogne weighing scale, measurement of juice flow: different types of flow meters- Magnetic & mass flow meter.

Juice heating: Objectives of juice heating, General Construction & working of Different types of juice heaters- Tubular /DCH/PTHE, Tubular heaters – HS, passes concept, heat transfer; Removal of condensate and NCG gases, scaling of tubes, cleaning & testing of heaters. concept of VLJH, Dynamic heaters. various factors affecting on heat transfer.

Unit – III **15 Hours**

Definition and concept of defication, sulphitation, double sulphitation, carbonation & phosphotation, chemicals used for juice clarification, physical & chemical properties of Sulphur, Lime, Phosphoric acids, settling agents, sulphur burning reaction, Action of lime/sulphur/phosphoric acid/settling agent on juice, Flocculent agents used for settling and their properties, dosing calculations for chemicals.

Concept of shock liming /preliming/simultaneous liming, Milk of preparation equipment working & construction details, Phosphoric acid preparation, Preparation of flocculants General working sulphur burner, General construction & working of modern continuous sulphur burner, sulphur sublimation and reasons, Properties of SO2 gas, Juice sulphiter working & construction details,

Unit – IV **15 Hours**

Composition of cane and juice – their difference , principles of cane juice clarification, Effect of lime on the different constituents of juice, effect of pH, effect of heating, different processes of cane juice clarification, Juice sulphiter – working &construction,

Clarifier: Principles of subsidation, floc formation. construction, working & significance of Flash tank. General construction & working of various clarifiers - 444 clarifier / rapi clarifier/ Single tray (SRT) clarifier.

Filtration: Preparation of mud, mud mixer, Vacuum filter: Construction & working effect of washing on pol in cake. Decanters: construction & working advantages & disadvantages.

Program Name	**BSc in Sugar Science & Technology**	Semester	**I**
Course title	**SUGAR PROCESSING–I: (Practical)**		
Course Code	**DSC 1-P**	No. of Credits	**02**
Contact hours	**48 Hours (4 Hours/ week)**	Duration of SEA/Exam	**4hours**
Formative Assessment Marks	**10**	Summative Assessment Marks	**40**

Experiments:

1. Brix Analysis by brix hydrometer
2. Use of polarimeter for Pol reading
3. Analysis of Primary juice /Mixed juice for Brix % , Pol % & Purity
4. Analysis of Filter cake for Pol % & Moisture %
5. Calibration of pH meter and analysis of juice for pH
6. Analysis of RS % & RS per 100 brix in Primary juice & clear juice
7. Determination of sucrose and calculation of gravity purity by double polarization.
8. Determination of melting point of sucrose and boiling point of different concentration sugar solutions.
9. Determination of settling rate in juice clarification.
10. Analysis of CaO content in Mixed juice & clear juice Analysis of quick lime – Available CaO, Unburnt %
11. Analysis of Milk of lime for slakability test
12. Analysis of bagacillo in mixed juice
13. Analysis of quick lime for available CaO content
14. Analysis of juice for dirt%

Reference Books:

1. Principles of sugar technology, Honig Pieter, Elesevier publishing company Amsterdam
2. Hand book of Cane Sugar Engineering, Hugot e., Elesevier Science publishing Co.Inc. New York.
3. Sugar Technology for Administrators in the Indian sugar factories; Manohar Rao,P.J.; Jayajirao Shinde Editor Bharatiya Sugar Jeevan Darshan Laxmi Rd. Pune.
4. Training manual for sugar mills.; Mangal Singh; Somaiya publications Pvt.Ltd. Mumbai.
5. Efficient Management of sugar factories, Mangal Singh, Somaiya publication Pvt.Ltd. Bombay
6. Cane Sugar Manufacture in India, Kulkarni, D.P., The Sugar Technologists Association of India N.Delhi.
7. System of Technical control for cane sugar factories in India; Varma, N.C. The Sugar Technologists Association of India N.Delhi.
8. Hand book of Cane Sugar Technology, Mathur R.B.L., Oxford DBH publishing Co.N.Delhi.
9. Unit operations in cane sugar production; Payne, J.N.; Elesevier pub Co. Amsterdam.
10. Introduction to cane Sugar Technology, Jenkins, Q.H., Elesevier scientific publishing company Amsterdam.

Program Name	**BSc in Sugar Science & Technology**	Semester	**I**
Course title	**SUGARCANE AGRICULTER (Theory)**		
Course Code	**DSC 2-T**	No. of Credits	**03**
Contact hours	**60 Hours (4 Hours/ week)**	Duration of SEA/Exam	**3hours**
Formative Assessment Marks	**20**	Summative Assessment Marks	**80**

Unit – I **15 Hours**

Origin, History and distribution of sugarcane growing regions of India. The taxonomic classification of sugarcane. Morphology – stem of sugarcane. Economic root system and inflorescence in sugarcane and growth phases in sugarcane. Economic important cane v/s beet sugar. Major varieties of sugarcane cultivated in Karnataka and their features.

Ecology: Temperature, Rainfall, Relative humidity (RH), Atmospheric Co2 concentration, Sunlight, Frost, Wind, Microclimate, Effect of greenhouse gases (GHGs) on cultivation of sugarcane.

Unit – II **15 Hours**

Basic concepts of sugarcane physiology : Photosynthesis, factors of influencing photosynthesis, effect of temperature, photoperiod, Transpiration, Growth promoters, Growth inhibitors.

Elements of Soils and their Characters; Definition of soil. Importance and functions of soils. soil profile, soil particles, structure, texture, density, porosity, physical properties, soil pH, Electrical Conductivity and Ion exchange process.

Soil organic matter, importance, characters and carbon and nitrogen ratio and its importance. Acid soils, saline and alkaline soils, their characters, formation, problems and their management practices. Meaning of soil fertility, soil fertility deciding factors, plant nutrients and their classification. Essential nutrients, Forms of nutrients required by plant, movement of nutrients towards roots, availability of nutrients. Organics, meaning and classification / types. Nitrogen, Phosphorus and potassium fertilizers and their characters and reactions in the soil. Complex. Mixed and liquid fertilizers and micronutrient fertilizers. Soil analysis, Recommendations of fertilizers based on soil test results.

Unit – III **14 Hours**

Production practices: Land preparation: Preparatory tillage, green manuring and application of bulky manures, seed material and seed rate, geometry of planting and planting depth, planting period, agronomy of late planted crop, planting methods, mechanical planters, aftercare. Sugarcane based cropping and

farming systems, companion cropping in sugarcane, sugarcane based farming systems.

Nutrition and fertilizer management : Time and method of N application, bio-fertilizers, Time and method of applying Bio-fertilizers, Ex situ composing of trash and press mud (modified Japanese method), Vermi-composting, major nutrients and micro nutrients.

Integrated weed management : Integrated weed control, herbicide, antidotes or softeners, surfactants and adjuvant, control of noxious, perennial weeds and methods of weed control measures.

Water management: Irrigation water requirement, Evapo-transpiration (ET) Water use efficiency (WUE), Different methods of Irrigation, Furrow method of irrigation Sprinkler irrigation, and Drip or trickle Irrigation.

Management of seed cane : Sett treatment, agronomy of seed cane, thermotherapy or heat therapy and Three-tier seed programme. Tissue culture and its importance in seed programme.

Unit – IV **15 Hours**

Pests and disease management

Pests: Shoot borer, top borer, internode borer, stalk borer, gurudaspur borer, root borer, White Grubs, Termites, Scale insect: (Green), Pyrillapurpusilla, Walker), White files, Non-insect pests, Biological control of sugarcane pests, parasites.

Diseases: Red rot, Smut, Wilt, Pineapple disease, Yellow Leaf Disease (YLD), Leaf spots, Ratoon stunning disease (RSD), Grassy Shoot Disease (GSD), Nematodes and Mosaic.

Management of ratoon cane

Importance of Ratoon management Ratoon cane Management practices, Time and method of fertilizer application, yield attributes of ratoon cane, ratoon v/s plant cane. Water requirement, gap filling, trash management, management of weeds, pests, and diseases associated with ratoon effect of growth regulators on sprouting and ratoon yield,

Ripening methods, Methods of cane purchase, Harvest strategy, Pre-harvest maturity survey, Methods of harvest, Mechanized harvesting. Quality assessment of late harvested cane, Composition of sugarcane and juice and quality parameters of juice, Post harvest losses and measures to reduces the losses. Cost of cultivation of sugarcane.

Program Name	**BSc in Sugar Science & Technology**	Semester	**I**
Course title	**SUGARCANE AGRICULTER (Practical)**		
Course Code	**DSC 2-P**	No. of Credits	**02**
Contact hours	**48 Hours (4 Hours/ week)**	Duration of SEA/Exam	**4hours**
Formative Assessment Marks	**10**	Summative Assessment Marks	**40**

1. Identification of important sugarcane varieties.
2. Soil collection process and interpretation of soil test results.
3. Calculation of fertilizer dose based on soil test report.
4. Identification of Pests and diseases.
5. Analysis of brix of cane sample by hand refractometer at various portion of the cane.
6. Analysis of cane sample for pol % - Cane weighment, Juice weighment, analysis of bagasse for pol % & moisture %, Analysis of juice for Brix %, Pol %, purity,
7. Quality analysis of Early &late maturing cane
8. Working of cost of cultivation of sugarcane.
9. Post harvest deterioration analysis and interpretation.

REFERENCE BOOKS:

1. Hartmann and Kester's – Plant propagation – Principles and practices – Hudscan T. Hartmann, Dale E. Kester, Fred T. Davies, Jr. Robert L. Geneve.
2. Textbook of Plant Physiology – C. P. Malik
3. Diseases of Crop plants in India – G. Rangaswami and A. Mahadevan
4. Plant Pathology – R. S. Mehrotra
5. Practical cytology – Applied Genetics and Biostatistics – H. K. Goswami and Rajeev Goswami
6. Recent Advances in Plant Diseases Vol-1 to 5-K.M. Chandniwala
7. Introduction to Principles of Plant Pathology – R.S. Singh
8. An Introduction to Plant Anatomy – Authur R. Eames and Laurence H. Mac Deniels.
9. Genetics and Plant Breeding – E. B. Babcock
10. Plant Taxonomy – O.P. Sharma
11. Plant Breeding – Theory and Techniques – S.K. Gupta
12. Breeding Asian Field Crops – John Milton Poehlman and Dhirendranath Borthakur.
13. Crop Production and Field Experimentation – Dr. V. G. Vaidya, K. R. Sahasrabudhe, Dr. V. S. Khuspe.
14. Agricultural Problems of India – A. N. Agrwal and Kundam Lal
15. Elementary Principles of Plant Breeding – H.K. Chaudhari
16. Trends in Agricultural Insect Pest Management – G.S. Dhaliwal and Ramesh Arora.

ProgramName	**BSc in Sugar Science &Technology**		**Semester**	**I**
Course title	**CHEMISTRY – I (Theory)**			
Course Code	**DSC 3T**		**No. of Credits**	**03**
Contact hours	**60Hours (4 Hours/ week)**		**Duration of SEA/Exam**	**3 hours**
Internal Assessment Marks	**20**		**Semester End Assessment Marks**	**80**

Unit – I Analytical Chemistry: **15 Hours**

Definitions of analysis, determination, measurement, techniques and methods. Classification of analytical techniques. Accuracy, precision, Errors: Determinate and indeterminate errors, absolute error, relative error.

Titrimetric analysis: Basic principle of titrimetric analysis. Classification:

Acid-basetitrimetry: Theory, Titration curve for strong acid- strong base titration.

Complexometric titrimetry: Indicators used for EDTA titration, methods employing EDTA –direct and indirect determinations, Application: determination of hardness of water.

Redox titrimetry: Theory of redox indicators, Applications of redox titrations.

Precipitation titrimetry: Theory, examples, indicators for precipitation titrations involving silver nitrate- Volhard's method.

Unit - II Atomic Structure & Periodicity of Elements **15Hours**

Atomic Structure: Review of Bohr's theory, postulates, limitations of Bohr's theory,dual behaviour ofmatter and radiation: deBroglie's equations, Heisenberg Uncertainty principle and their related problems. Quantum numbers and their significance. Aufbau's principle, Hund's rule, (n+l) rule, Pauli's exclusion principle, electronic configurations of the atoms (atomic number up to 54). Concept of exchange energy. Anomalous electronic configurations.

Periodic properties of elements: General introduction of modern periodic table,Classification of elements into s, p, d and f blocks, Periodicity properties-

ionic radii, ionization Energy, electron gain enthalpy and electronegativity (definition), Effective nuclear charge, screening effect.

Unit - III **15 Hours**

Carbohydrates I : Introduction, definition and classification, D and L structure of glucose, Fructose, Haworth and Fischer structure of (+)-Glucose and (-)-Fructose, Howarth structure of sucrose, Oxidation of (+)-Glucose by Nitric Acid, Osazone formation of (+)-Glucose and (-)-Fructose, Conversion of aldose into Ketose and ketose to aldose, Formation of glycosides, Configuration about C-1 (anomers), Methylation, Mutarotation, Howarth Structure and composition of Disaccharides(+)-Sucrose, (+)-Maltose, (+)-Lactose, Polysaccharides starch and cellulose structures, Reducing and Non-reducing sugars. Biological importance of carbohydrates.

Unit - IV GASES & LIQUIDS **15 Hours**

Gaseous state: Review of kinetic theory of gases, van der Waals equation of state Boyle temperature. Maxwell's Boltzmann distribution law of molecular velocities(derivation not required), most probable, average and root mean square velocities. Relation between RMS, average and most probable velocity. Collision frequency, collision diameter, Collision cross-section, collision number and mean free path. Critical phenomena: Andrew's isotherms of CO_2, critical constants and their relation between critical constants and van der Waals constants (no derivation, numerical problems), law of corresponding states. Reduced equation of states (derivation).

Distribution Law: Nernst Distribution Law - Statement and its derivation. Distribution constant, factors affecting distribution constant.

Program Name	**B.Sc. in Sugar Science &Technology**	Semester	**I**
Course title	**CHEMISTRY – I (**Practical**)**		
Course Code	**DSC 3P**	No. of Credits	**02**
Contact hours	**48 hours (4 Hours/ week)**	Duration of SEA/Exam	**4hours**
Internal Assessment Marks (IA)	**10**	Semester End Assessment Marks (SEA)	**40**

A. Demonstration of calibration of glasswares (Burette, pipette) and weights (grams and milligrams)

B. Preparation of standard solution, calculation of mass of the solute to be dissolved in 250 ml solution to get required normally.

C. Volumetric estimations:

1. Preparation of standard oxalic acid solution and determination of potassium permanganate using oxalic acid solution
2. Preparation of standard potassium dichromate solution and determination of iron (II) using potassium dichromate solution.
3. Preparation of standard EDTA solution and estimation of total hardness of water
4. Estimation of carbonate of bicarbonate in a mixture using phenolphthalein and methyl orange indicators.
5. Estimation of carbonate of hydroxide in a mixture using phenolphthalein and methyl orange indicators.
6. Estimation of phenol by bromination method
7. Estimation of aniline by bromination method.
8. Estimation of acetamide by hydrolysis method.
9. Estimation of zinc using standard EDTA solution.
10. Determination of alkali content in antacids

Examination

In the practical examination, in a batch at least 15 (Fifteen) students may be made. Selection of experiments may be done by the students based on lots. Viva questions may be asked on any of the experiments prescribed in the practical syllabus**.**

Distribution of Marks:

Accuracy		25
Calculation & Presentation		05
Journal		05
Viva		05
Total	**=**	**40**

Deduction of marks for accuracy: : ±0.2 CC -25 marks, ± 0.4 CC- 22 marks, ±0.6 CC- 20 marks, ±0.8 CC- 15 marks, ±0.9 CC- 12 marks, above ±0.9 – zero marks.

References

1. Vogel's Textbook of Quantitative Chemical Analysis, J. Mendham, R.C. Denney, J.D.Barnesand M.J.K. Thomas, 6th edition, Third Indian Reprint, Pearson Education Pvt.Ltd.(2007).
2. Fundamentals of Analytical Chemistry, D.A. Skoog, D.M. West, Holler and Crouch, 8th edition, Saunders College Publishing, New York (2005).
3. Analytical Chemistry, G.D. Christian, 6th edition, Wiley-India (2007).
4. Practical Volumetric Analysis, Peter A C McPherson, Royal Society of Chemistry, Cambridge, UK (2015).
5. Morrison, R. N. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education)
6. Finar, I. L. *Organic Chemistry (Volume I)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education)
7. McMurry, J. E. *Fundamentals of Organic Chemistry,* 7th Ed. Cengage Learning India Edition, 2013
8. Organic Reaction mechanism by V. K. AhIuwalia and K. Parashar (Narosa Publishers).
9. Organic Chemistry by S. M. Mukherji, S. P. Singh and R. K. Kapoor. (Narosa Publishers)
10. A Guide book to mechanism in Organic Chemistry by Peter sykes. Pearson.

SEMESTER I
CERTIFICATE COURSE

Program Name	**BSc in Sugar Science & Technology**	Semester	**I**
Course title	**SOIL & WATER ANALYSIS FOR INDUSTRIAL APPLICATION**		
Course Code	**SEC 1-T**	No. of Credits	**02**
Contact hours	**15 Hours Theory** **8 Hours Practical**	Duration of SEA/Exam	**2 hours**
Formative Assessment Marks	**10**	Summative Assessment Marks	**40**

Introduction:

Introduction to Analytical Chemistry and its interdisciplinary nature. Concept of sampling. Importance of accuracy, precision and sources of error in analytical measurements. Presentation of experimental data and results, from the point of view of significant figures.

Analysis of soil: Composition of soil, Concept of pH and pH measurement, complexometric titrations, Chelation, Chelating agents, use of indicators. Determination of pH of soil samples. Estimation of Calcium and Magnesium ions as Calcium carbonate by complexometeric titration.

Nutrients: Macro and Micro nutrients of soils.

Analysis of water: Definition of pure water, sources responsible for contaminating water, water sampling methods, water purification methods. Determination of pH, acidity and alkalinity of a water samples. Determination of dissolved oxygen (DO) of a water sample.

- Analysis of soil sample for pH, Macro & Micro nutrients
- analysis of water sample for pH, TDS, TSS, Hardness, DO

REFERENCE BOOKS:

1. Willard, H.H., Merritt, L.L., Dean, J. & Settoe, F.A. Instrumental Methods of Analysis. 7th Ed. Wadsworth Publishing Co. Ltd., Belmont, California, USA, 1988.
2. Skoog. D.A. Holler F.J. & Nieman, T.A. Principles of Instrumental Analysis, Cengage Learning India Ed.
3. Harris, D.C. Quantitative Chemical Analysis, W.H. Freeman.
4. Day, R. A. & Underwood, A. L. Quantitative Analysis, Prentice Hall of India.
5. Freifelder, D. Physical Biochemistry 2nd Ed., W.H. Freeman and Co., N.Y. USA (1982).
6. Copper, T.G. The Tools of Biochemistry, John Wiley and Sons, N.Y.USA. 16(1977).
7. Vogel, A. I. Vogel's Qualitative Inorganic Analysis 7th Ed., Prentice Hall.

THE COURSE STRUCTURE AND SYLLABUS OF UNDER GRADUATE

B. Sc. (Sugar Science & Technology)

II - SEMESTER

SEMESTER II

Program Name	**BSc in Sugar Science & Technology**	Semester	**II**
Course title	**SUGAR PROCESSING–II: EVAPORATOR (Theory)**		
Course Code	**DSC 4-T**	No. of Credits	**03**
Contact hours	**60 Hours (4 Hours/ week)**	Duration of SEA/Exam	**3hours**
Formative Assessment Marks	**20**	Summative Assessment Marks	**80**

Unit – I **15 Hours**

Evaporator basic: Concept of live steam/exhaust steam/vapour, Heat transfer & condensation, Basic concept of evaporator body, Working & construction of Robert body, Evaporator body – Major accessories, steam distribution to calandria, juice distribution, Study of different types of evaporators, Rising & falling film evaporator,

Unit – II **15Hours**

Evaporator operation: single effect Vs multiple effect evaporator, vapour cell and pre evaporators, Rileuxe principles, Evaporation under vacuum, vacuum creation, Types of condensers – Barometric/multijet/single entry/counter current /co –current; removal of condensate and non condensable gases, Online Brix measuring devices

Unit – III **15 Hours**

Vapor Bleeding System: Use of steam table, Vapour bleeding calculations for Quadruple & quintiple effect,Dessin's formulas, Specific evaporation coefficient calculation & importance, estimation of evaporation rate based on brix data, BPR and its calculations

Unit – IV **15 Hours**

Evaporator performance: Calculations for HS / steam/ vapour/ juice,Factor affecting evaporator performance; operational problems, Comparative study of Quadruple Vs Quintuple effects. Modern evaporator configuration.

Evaporator operation & Cleaning: Testing of evaporator bodies after maintenance, Procedure for starting of evaporator body, operating procedures, Liquidation procedure, Chemical cleaning of evaporator – Soda boiling & descaling procedures followed on general cleaning day. chemicals used/ concentration/process; Mechanical descaling of evaporator tubes.

Program Name	**BSc in Sugar Science & Technology**		Semester	**II**
Course title	**SUGAR PROCESSING–II: (Practical)**			
Course Code	**DSC 4-P**		No. of Credits	**04**
Contact hours	**48 Hours (4 Hours/ week)**		Duration of SEA/Exam	**4 hours**
Formative Assessment Marks		**10**	Summative Assessment Marks	**40**

Experiments:

1. Analysis of syrup for Brix % & purity
2. Analysis of RS % & RS per 100 brix in clear juice & syrup
3. Analysis of clear juice & syrup for ICUMSA colour
4. Estimation of % transmittance of clear juice
5. Analysis of condensate for – pH, TDS, Sugar test, Conductivity, COD
6. Evaporator scale analysis for various contents
7. Analytical of intermediate products of boiling house – Clear Juice / Syrup/ Massecuite / Molasses for RS% / Colour/
8. Turbidity in clear juice and syrup by ICUMSA method.
9. Analysis of conductivity ash % of clear juice /syrup/ molasses
10. Estimation of RS/Ash ratio of clear juice / syrup / molasses
11. Analysis of Carbonated and sulphated ash % - Final molasses.

Reference Books:

1. Principles of sugar technology, Honig Pieter, Elesevier publishing company Amsterdam
2. Hand book of Cane Sugar Engineering, Hugot e., Elesevier Science publishing Co.Inc. New York.
3. Sugar Technology for Administrators in the Indian sugar factories; Manohar Rao,P.J.; Jayajirao Shinde Editor Bharatiya Sugar Jeevan Darshan Laxmi Rd. Pune.
4. Training manual for sugar mills.; Mangal Singh; Somaiya publications Pvt.Ltd. Mumbai.
5. Efficient Management of sugar factories, Mangal Singh, Somaiya publication Pvt.Ltd. Bombay
6. Cane Sugar Manufacture in India, Kulkarni, D.P., The Sugar Technologists Association of India N.Delhi.
7. System of Technical control for cane sugar factories in India; Varma, N.C. The Sugar Technologists Association of India N.Delhi.
8. Hand book of Cane Sugar Technology, Mathur R.B.L., Oxford DBH publishing Co.N.Delhi.
9. Manufacture and Refining of Raw cane sugar; Baikow, V.E., Elesevier publishing Co. Am Sterdam London New-york.
10. Unit operations in cane sugar production; Payne, J.N.; Elesevier pub Co. Amsterdam.
11. Machinery and Equipment of the cane sugar factory, Tromp, L.A., Norman Rodger, 7 & 8 Idol Lane.
12. Sugar Science and Technology, Birch, G.G. Parker, K.J. Applied science publishers Ltd. London.
13. The principles of cane sugar manufacture, Davies, J.G., Norman Rodger; London
14. Technology for sugar Refinery Workers, Oliver Lyle, Chapman & Hall Ltd. London
15. Introduction to cane Sugar Technology, Jenkins, Q.H., Elesevier scientific publishing company Amsterdam.
16. Industrial utilization of sugar cane and its Co-products , Manohar rao, P.J. , ISPCK publishers & Distibutors N.Delhi

Program Name	**BSc in Sugar Science & Technology**	Semester	**II**
Course title	**SUGAR ENGINEERING–I: MILLING AND BOILER (Theory)**		
Course Code	**DSC 5-T**	No. of Credits	**03**
Contact hours	**60 Hours (4 Hours/ week)**	Duration of SEA/Exam	**3 hours**
Formative Assessment Marks	**20**	Summative Assessment Marks	**80**

Unit – I **15 Hours**

Harvesting methods & Quality of cane -Definitions and concept of various terms : Cane, Binding Material, Extraneous Matter, Pol, Brix, Recovery, Juice, Bagasse. Composition of cane. Harvesting- methods, period. Post harvest sugar losses. Effect of microbes on sugar losses. Extraneous matter and its effect on milling, boiler and sugar processing. Cane transportation, effect of cut to crush delay.

Cane preparation : cane weighing, cane unloading system, General arrangement & working of cane carrier, feeder tables, cane preparatory equipments – Kicker, leveler, cutter, fibrizer, shredder etc, Preparatory index, prepared cane carrier, Effect on cane preparation on sugar losses and milling efficiency. Tramp iron separator.

Unit – II **15 Hours**

Milling: General arrangement of mills & drive assembly, different parts of mill assembly, concept of mill & milling tandem. Working of mill, Juice extraction from cane, maceration and simple imbibition,

Primary Juice, Secondary Juice, Maceration, Imbibition Water, Bagasse. compound imbibition, mill sanitation, raw juice screening, rotary screens, Mill extraction, Primary extraction, Bagasse & Juice quality, Measurement and weighment of juice – Magnetic flow / mass flow/load cell base weighing tank, Normal quantities of various products, Idea about diffusion.

Unit – III **15 Hours**

General boiler mounting/accessories & working: General boiler types, Water tube boiler- General parts – furnace / combustion zone / feed water tank/feed pump/ steam drum /mud drum /super heater/level indicators/ economizer/air heater/ID fan/FD fan/SA fan/ etc, High pressure & low pressure boilers

Unit – IV **15 Hours**

Boiler operations & water quality: Boiler blow down, Reasons for boiler failures, Boiler preventive maintenance, Tubes internal chemical cleaning, water tube boilers – fire side cleaning.

Cogeneration: Cogeneration in sugar industry, cogeneration potential & achievement in India. Bagasse based cogeneration. Steam turbine: Description of working of extraction & condensing type turbine. live steam and exhaust steam. PRDS concept. Factors affecting steam pressure.

Program Name	**BSc in Sugar Science & Technology**	Semester	**II**
Course title	**SUGAR ENGINEERING–I: (Practical)**		
Course Code	**DSC 5-P**	No. of Credits	**02**
Contact hours	**48 Hours (4 Hours/ week)**	Duration of SEA/Exam	**4 hours**
Formative Assessment Marks	**10**	Summative Assessment Marks	**40**

1. Analysis of prepared cane for preparatory index
2. Analysis of primary extraction or crusher extraction– Pol base & juice base.
3. Analysis of brix of cane sample by hand refractometer at various points.
4. Analysis of cane sample for pol % - Cane weighment, Juice weighment, analysis bagasse for pol% and moisture%, analysis of juice for brix, pol & purity.
5. Determination of pol% & moisture % in bagasse.
6. Estimation of fibre % in cane.
7. Analysis of spray water for pH / TDS / Sugar test.
8. Analysis of boiler water& feed water for
    a. pH,
    b. TDS,
    c. Caustic Alkalinity,
    d. Total Alkalinity,
    e. Oxygen,
    f. Hardness,

9. Analysis of boiler water for silica content by spectrophotometer
10. Analysis of blow down water for pH , TDS, hardness
11. Analysis of boiler water chemicals for various parameters
12. Testing of boiler treatment chemicals as per the chemical manufacturers instruction manual

Reference Books:

1. Practical boiler water treatment Handbook, N. Manivasakam, By Shakti Book Services, Coimbatore
2. Training manual for sugar mills. Mangal Singh; Somaiya publications Pvt.Ltd. Mumbai.
3. Efficient Management of sugar factories, Mangal Singh, Somaiya publication Pvt.Ltd. Bombay.
4. System of Technical control for cane sugar factories in India; Varma, N.C. The Sugar Technologists Association of India N.Delhi. Principles of sugar technology, Honig Pieter, Elesevier publishing company Amsterdam
5. Hand book of Cane Sugar Engineering, Hugot e., Elesevier Science publishing Co. Inc. New York.
6. Machinery and Equipment of the cane sugar factory, Tromp, L.A., Norman Rodger, 7 & 8 Idol Lane.
7. Sugar Science and Technology, Birch, G.G. Parker, K.J. Applied science publishers Ltd. London.
8. The principles of cane sugar manufacture, Davies, J.G., Norman Rodger; London

ProgramName	BSc in Sugar Science &Technology		Semester	**II**
Course title	CHEMISTRY – II (Theory)			
Course Code	**DSC 6T**		No. of Credits	**03**
Contact hours	60Hours (4 Hours/ week)		Duration of SEA/Exam	**3 hours**
Internal Assessment Marks		20	Semester End Assessment Marks	**80**

Unit – I Separation methods **15 Hours**

Chromatography: General Introduction, definition, terms and parameters used in chromatography, classification of chromatographic methods, criteria for selection of stationary and mobile phase, nature of adsorbents. Principles of column, thin layer and paper chromatography, Column efficiency, factors affecting the column efficiency.Mechanism of Thin layer chromatography (TLC), Rf value, qualitative applications.

Ion exchange Chromatography, types of the resins with examples-cation exchange and anion exchange resins, mechanism of cation and anion exchange process and applications of ion-exchange chromatography (softening of hard water, separation of lanthanides,).

SolventExtraction: Types-batch, continuous, efficiency, selectivity, distribution coefficient, factors affecting the efficiency of extraction.

Unit – II Chemical bonding&molecular structure **15 Hours**

Ionic Bonding*:* General characteristics of ionic compounds. lattice energy and salvation energy and the importance in the context of stability and solubility of ionic compounds. Born-Haber cycle and its applications.

Polarizing power and polarizability: Fajan's rules, ionic character in covalent compounds and percentage of ionic character.

Covalent bonding: General characteristics of covalent compounds. Valance Bond theory, hybridization, types of hybridization, Limitations of Valence Bond Theory. Shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of linear, trigonal planar, square

planar, tetrahedral, trigonal bipyramidal and octahedral arrangements. Concept of resonance and resonating structures of NO_3^-, CO_3^{2-} and SO_4^{2-}.

Molecular Orbital Theory: LCAO method, bonding and antibonding MOs andnonbondingcombination of orbitals for s-s, s-p and p-p combinations, MO treatment of homo nuclear diatomic molecules: H_2,O_2,N_2.

Unit - III Bonding in Organic Molecules and Mechanism of Organic reactions **15 Hours**

Classification and nomenclature of organic compounds, Hybridization, Shapes of organic molecules, Influence of hybridization on bond properties.

Nature of bonding in Organic molecules Types of chemical bonding, Formation of Covalent bond, localized and delocalized, conjugation and cross conjugation, concept of resonance, electronic displacements: Inductive effect, Electrometric effect, Resonance and Hyper conjugation with examples. Concept of resonance and aromaticity, Huckel rule, anti-aromaticity explanation with examples.

Mechanisms of Organic Reactions-I

Notations used to represent electron movements and directions of reactions- curly arrows, formal charges. Types of bonds breaking- homolytic and heterolytic. Types of reagents-Electrophiles, nucleophiles, nucleophilicity and basicity. Types of organic reactions- substitution, addition, elimination, rearrangement and pericyclic reactions, explanation with examples. Markonikov's rule, &Saytzeff rule.

Unit - IVChemical Kinetics&Solids **15 Hours**

Chemical Kinetics I: Review of reaction rates, order and molecularity.

Factors affecting rates of reaction: concentration pressure, temperature, catalyst, etc. Examples for different orders of reactions. Derivation of integrated rate equations for zero and second order reactions (for equal concentrations of

reactants). Half–life of a reaction (numerical problems). Methods for determination of order and rate constant by half-life period and differential equation method for first order reaction.

Solids: Types of solids. Unit cell and space lattice, anisotropy of crystals, size and shape of crystals, Laws of Crystallography: Law of constancy of interfacial angles, Law of rational indices, Law of symmetry, Symmetry elements, X–Ray diffraction by crystals: Bragg's law and derivation of Bragg's equation, Defects in crystals, glasses and liquid crystals. Numerical problems.

Reference Books

1. Concise Inorganic Chemistry: J D Lee, 4th Edn, Wiley, (2021)
2. Fundamentals Concepts of Inorganic Chemistry, Vol 1 and 2, 2nd Edition, Asim K Das, CBS Publishers and Distributors, (2013)
3. Basic Inorganic Chemistry, F A Cotton, G Wilkinson and P. L. Gaus, 3rd Edition. Wiley. India 4. Inorganic Chemistry, 2nd Edn. Catherine E. Housecroft and A.G. Sharpe, Pearson Prentice Hall (2005)
4. Atkins Physical Chemistry.8th Edition. Peter Atkins & Julio De Paula Oxford University Press.\
5. Physical Chemistry by Samuel Glasstone, ELBS (1982).
6. A Text book of Physical Chemistry, A S Negi & S C Anand, New Age International Publishers (2007).
7. Principles of Physical Chemistry, Puri, Sharma & Pathania, Vishal Publishing Co.
8. A Text Book of Physical Chemistry P.L.Soni , O.P. Dharmarhaand and U.N.Dash, Sultan Chand and Sons.
9. Advanced Physical Chemistry, Gurdeep Raj, Goel Publishing House (2018)

ProgramName	**BSc in Sugar Science &Technology**		Semester	**II**
Course title	**CHEMISTRY – II (Practical)**			
Course Code	**DSC 6P**		No. of Credits	**02**
Contact hours	**48 hours (4 Hours/ week)**		Duration of SEA/Exam	**4 hours**
Internal Assessment Marks (IA)	**10**		Semester End Assessment Marks (SEA)	**40**

Qualitative analysis of Organic compounds: (Organic Spotting)

1) Salycilicacid, p-Nitrobenzoic acid,phthalic acid, cinnamic acid
2) o-Cresol, p-Cresol, Resorcinol, α-napthol, β-napthol
3) o-Nitro aniline, p-Nitroaniline, p-Toluidine, p-Chloroaniline, p-Bromoaniline,
4) Ethyl benzoate, Salicylaldehyde, Acetophenone, Benzamide, Urea, Acetanilide, Nitrobenzene

References

1) Vogel's Text Book of Qualitative Chemical Analysis, ELBS
2) Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., TextbookofPractical OrganicChemistry, Prentice-Hall, 5th edition, 1996

SEMESTER II
CERTIFICATE COURSE

Program Name	**BSc in Sugar Science & Technology**	Semester	**II**
Course title	**PREPARATION, STERLIZATION & ISOLATION OF CULTURE MEDIA FOR INDUSTRIAL APPLICATION**		
Course Code	**SEC 1-T**	No. of Credits	**02**
Contact hours	**15 Hours Theory** **8 Hours Practical**	Duration of SEA/Exam	**2 hours**
Formative Assessment Marks	**10**	Summative Assessment Marks	**40**

Scope and Development of Microbiology: History of microbiology, characteristics and classification of microorganisms, Structure of Prokaryotic and eukaryotic microorganisms. Scope and applications of microbiology.

Sterilization and preparation of culture Media: Physical and chemical methods of sterilization. Definition, components, types, and preparation of enrichment and preservative media, Cultivation of microorganisms- culture media, Isolation of microorganisms- serial dilution, streak plate, pour plate, and spread plate method. Characterization and identification of colonies, preservation of culture. Various equipment like Autoclave, Laminar air flow, Hot air oven, Incubator, BOD chamber, and their applications.

Staining techniques and methods in microbiology: Staining – simple and differential, fluorescent, negative staining, and structural staining – capsule, spore, and cell wall and reserve food material. Staining of anaerobic microbes.

Nutrition and growth of microbes: Nutritional requirements, growth, and growth curve- counting of bacteria, synchronous growth, and continuous culture growth as affected by environmental factors.

Practical's:

1) Preparation and Sterilization of culture media-Agar media, Malt extract media, Preparation of slants and stabs.
2) Preparation of Bacterial culture slides and staining by simple and Gram staining.
3) Serial dilution method.
4) Microscopic examination of microorganisms like- Bacteria, Yeast, Fungai,Etc.

REFERENCE BOOKS:

1. Pelczar, M.J. Chan, Eosa and Kreig, N.R, 1993, Microbiology Mcgraw Hill Inc, New york.
2. Prescott, L.M. Heviey,J.P. and Klein,D.A., 1996, Microbiology, WMC Brown Publishers, New York.
3. Holt,J.S.Krieg, N.R.Sneath, P.H.S. and Williams,S.T. 1994 Bergey's manual of systematic Bacteriology, 9th Ed Williams and Wilkins, Baltimore.
4. Sullia,S.B., and Shantaram,S. 1998 General Microbiology, Oxford IBH, New Delhi.
5. Microbiology: Fundamentals and Applications. Purohit. Agrobois.
6. Edward Alcamo.I. 1997, Fundamentals of Microbiology 5th Ed, Adelison Wesley Longman. Inc New York.
7. Madigan,M.T., Martin,J.M. and Parker.J. 1997 Brock Biology of Microorganisms. 8th Ed. Mcgraw Hill Inc, New York.
8. Matthews, R.E.F. 2005 Plant virology.
9. Alexander. 1997. Introduction to soil Microbiology, John Wiley and Sons Inc, New York.
10. Frazier, W.C. and Westhaff, D.C.1998 Food Microbiology, TATA Mcgraw Hill, New Dehhi Publications

B.Sc. Sugar Science and Technology Degree Examination
Sugar Science and Technology
Question Paper Pattern

Time: 3 hours **Max. Marks: 80**

Instructions to candidates:

1. **All Questions are compulsory.**
2. **Answer all the questions in the same answer book.**
3. **Draw neat labeled diagram and give equations wherever necessary.**

	SECTION- A	
1.	**Answer any Ten of the following (Three questions from each unit)**	**(10 X 2 =20)**
	a. **b.** **c.** **d.** **e.** **f.** **g.** **h.** **i.** **j.** **k.** **l.**	
	SECTION- B	
	Answer any Six of the following. (Two questions from each unit)	**(6 X 5 = 30)**
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
	SECTION- C	
	Answer any Three of the following. (One questions from each unit)	**(3 X 10 = 30)**
10.		
11.		
12.		
13.		

***Note: 10 marks questions may split into a and b.**

Scheme of Evaluation for Practical Examination

	Particulars	Marks Allotted
1	**Experimental preparation involving the following***	**30**
2	**Journal(record)assessment**	**05**
3	**Oral performance (Viva-voce)**	**05**
	Total	**40**
*	Brief description & tabulation	05
	Diagrams / Formula /Equation	02
	Preparation of required solutions and Experimental set-up	05
	Record of observation and performance of experiment	10
	Calculation including drawing graph	05
	Accuracy of result with unit	03

- Formative Assessment Marks will given as per University guidelines.

B.Sc. Sugar Science and Technology Degree Examination
Question Paper Pattern for
SEC

Time: 2 hours **Max. Marks: 40**

Instructions to candidates:

1. **All Questions are compulsory.**
2. **Answer all the questions in the same answer book.**
3. **Draw neat labeled diagram and give equations wherever necessary.**

	SECTION- A	
1.	**Answer any Five of the following**	**(5 X 2 =10)**
	a. **b.** **c.** **d.** **e.** **f.** **g.**	
	SECTION- B	
	Answer any Three of the following.	**(3 X 5 = 15)**
2.		
3.		
4.		
5.		
	SECTION- C	
	Answer any Three of the following.	**(3 X 5 = 15)**
6.		
7.		
8.		
9.		

Semester III								
Sl. No.	**Course Code**	**Course**	**No. of Teaching hours per week**	**Total of Internal Assessment marks**	**Final Examination Marks**	**Total marks**	**Exam Hours**	**Credits**
1		Language 1	4	20	80	100	3 Hours	3
2		Language 2	4	20	80	100	3 Hours	3
4	DSC-7T	Sugar Processing-III CRYSTALLIZATION	4	20	80	100	3 Hours	3
5	DSC-7P	Sugar Processing-III Practical	4	10	40	50	4 Hours	2
6	DSC-8T	SUGAR FACTORY CHEMICAL CONTROL	4	20	80	100	3 Hours	3
7	DSC-8P	SUGAR FACTORY CHEMICAL CONTROL Practical	4	10	40	50	4 Hours	2
8	DSC-9T	CHEMISTRY III	4	20	80	100	3 Hours	3
9	DSC-9P	CHEMISTRY III Practical	4	10	40	50	4 Hours	2
10		Elective 1 - INDUSTRIAL SAFETY	2	10	40	50	1:30 Hours	2
11		Compulsory-1 Practical Knowledge Skill	2	10	40	50	4 Hours	2
						750		25

Semester IV								
Sl. No.	**Course Code**	**Course**	**No. of Teaching hours per week**	**Total of Internal Assessment marks**	**Final Examination Marks**	**Total marks**	**Exam Hours**	**Credits**
1		Language 1	4	20	80	100	3 Hours	3
2		Language 2	4	20	80	100	3 Hours	3
4	DSC-10T	Alcohol Technology-I: FERMENTATION PROCESS	4	20	80	100	3 Hours	3
5	DSC-10P	Alcohol Technology-I: Practical	4	10	40	50	3 Hours	2
6	DSC-11T	Sugar Engineering-II : Instrumentation & Automation	4	20	80	100	3 Hours	3
7	DSC-11P	Sugar Engineering-II : Practical	4	10	40	50	3 Hours	2
8	DSC-12T	CHEMISTRY IV	4	20	80	100	3 Hours	3
9	DSC-12P	CHEMISTRY IV Practical	4	10	40	50	3 Hours	2
10		Elective 2 - ANALYTICAL INSTRUMENTATION	2	10	40	50	1:30 Hours	2
11		Compulsory-2 Practical Knowledge Skill	2	10	40	50	1:30 Hours	2
						750		25

SEMESTER III

Program Name	**BSc in Sugar Science & Technology**	Semester	**III**
Course title	**SUGAR PROCESSING–III:CRYSTALLIZATION (Theory)**		
Course Code	**DSC 7-T**	No. of Credits	**03**
Contact hours	**60 Hours (4 Hours/ week)**	Duration of SEA/Exam	**3hours**
Formative Assessment Marks	**20**	Summative Assessment Marks	**80**

Unit–I **14Hours**

Syrup treatment & General pan boiling concepts: Syrup treatment, continuous syrup sulphiter, reasons for syrup sulphitation, Definitions of various technicalterm – syrup/ massecuite /mother liquor/molasses/ magma /seed/ grain/ slurry/ cutting/ footing/, Solubility of sugar in water, concept of super saturation, Different zones of super saturation, Classen's theory of Pan Boiling, Aims of pan boiling, techniques of pan boiling, Mechanism of crystal growth.

Unit–II **14Hours**

Vacuum pan & accessories: General construction of Batch type lowhead pan & it's working, various accessories of vacuum pan, Different types of batch type calandria pans, different types of calandria-their advantages and disadvantages, design aspects of batch pan, circulation in pan, mechanical circulator.

General construction and working of horizontal continuous vacuum pan, advantages and disadvantages.

Unit–III **14Hours**

Massecuite boiling Practices: Different massecuite boiling schemes (4Massecuite, 3massecuite & 3½ massecuites boiling), Highgrade Massecuite boiling practice: Startingof pan,Panwashing,Introductionofmaterialinpans,Footing/Grainingpractice, Washingoffooting,,2Apanstrikesconcept,Pancutting,Singlepanboiling,pan tightening, vacuum boiling, vacuum braking, pan discharging and related operations.

Unit–IV **14Hours**

Low grade (B & C) massecuite boiling practice: Molasses Conditioning, Starting of pan, Pan washing, Introduction of material in pans, Concentration of graining material, Tests for slurry dosing, graining practice, Slurry dosing, Grain control, Grain washing,

Grain filling , 2B/2C pan strikes concept, Pan cutting, Single pan boiling, pan tightening, vacuum boiling, vacuum braking, pan discharging and related operations. False grains& Conglomerates: formation, causes and prevention.

Unit–V **04 Hours**

Various formulae's for- % exhaustion / Crystal content / purity drop, Cobenz diagram & Estimation of molasses /sugar quantity by using Cobenz diagram.

Program Name	**BSc in Sugar Science & Technology**	Semester	**III**
Course title	**SUGAR PROCESSING–III:(Practical)**		
Course Code	**DSC 7-P**	No. of Credits	**02**
Contact hours	**48 Hours (4 Hours/ week)**	Duration of SEA/Exam	**4 hours**
Formative Assessment Marks	**10**	Summative Assessment Marks	**40**

Experiments:

1. Analysis of massecuite for brix, pol purity and non-sugar
2. Analysis of massecuite & molasses for purity drop, % exhaustion & crystal content
3. Analysis of massecuite and molasses for ICUMSA color.
4. Analysis of molasses for RS% and TRS%.
5. Nutch molasses sample collection & analysis for Brix % & Purity
6. Sugar analysis for different grades as per Indian standard
7. Analysis of sugar sample for
    a. ICUMSA colour,
    b. Pol% &Moisture%,
    c. Conductivity Ash %,
8. Estimation of saturation temperature of massecuite by using Saturoscope.

REFERENCEBOOKS:

1. Principles of sugar technology, Honig Pieter, Elesevier publishing company Amsterdam.
2. Handbook of Cane Sugar Engineering, Hugote., Elesevier Science publishing Co.Inc. New York.
3. Notes for Sugar crystallisation ByDr.M.B.Londhe,VSIPune
4. Sugar Technology for Administrators in the Indian sugar factories; ManoharRao,P.J.;Jayajirao Shinde Editor Bharatiya Sugar Jeevan Darshan Laxmi Rd. Pune.
5. Training manual for sugar mills. Mangal Singh; Somaiya publications Pvt. Ltd. Mumbai.
6. Efficient Management of sugar factories, MangalSingh, Somaiya publication Pvt. Ltd. Bombay
7. Cane Sugar Manufacture in India, Kulkarni,D.P.,TheSugarTechnologists Association of India N.Delhi.
8. System of Technical control for cane sugar factories in India;Varma,N.C. The Sugar Technologists Association of India N. Delhi.
9. Hand book of Cane Sugar Technology, Mathur R.B.L.,Oxford DBH publishing Co. N. Delhi.

SEMESTER III

Program Name	**BSc in Sugar Science & Technology**	Semester	**III**
Course title	**SUGAR FACTORY CHEMICAL CONTROL(Theory)**		
Course Code	**DSC 8-T**	No. of Credits	**03**
Contact hours	**60 Hours (4 Hours/ week)**	Duration of SEA/Exam	**3 Hours**
Formative Assessment Marks	**20**	Summative Assessment Marks	**80**

Unit – I **12 Hours**

General: Weighment system & estimation of % cane figures – MJ/imbibition/bagasse, Calculation for estimation of Pol in bagasse, Pol in MJ, Pol % cane.

Unit – II **12Hours**

Milling control: Fundamental equations for milling control**,** Mill extraction, fiber % cane, fiber % bagasse, Estimation of RME,Deer & RME (Mittal), Imbibition % cane, Imbibition % fibre, dilution indicator.

Unit – III **12 Hours**

Sugar balance and its losses – Estimation of sugar losses –bagasse/filter cake/ molasses/ recovery/ unknown, Estimation of Pol balance, RS balance and total losses.

Unit – IV **12 Hours**

Available sugar / available molasses, General stock taking, Reduced boiling house control, **Boiling** house recovery, Reduced BHR, Purity drop, % exhaustion, Massecuite % cane, Steam % cane.

Unit – V **12 Hours**

Overall: Preparation of daily manufacturing report (DMR), RT(8)C,RT(7)C.

Program Name	**BSc in Sugar Science & Technology**	Semester	**III**
Course title	**SUGAR FACTORY CHEMICAL CONTROL (Practical)**		
Course Code	**DSC 8-P**	No. of Credits	**02**
Contact hours	**48 Hours (4 Hours/ week)**	Duration of SEA/Exam	**4 hours**
Formative Assessment Marks	**10**	Summative Assessment Marks	**40**

Experiments:

1. Analysis of various chemicals used in sugar industry
    a. Lime
    b. Phosphoric acid
    c. Mill sanitation chemicals
    d. Antiscalents
    e. Sulphur
    f. Caustic Soda
    g. Hydrogen peroxide

2. Analysis of clear juice /syrup for estimation of
    a. Apparent pol %
    b. Sucrose % by double polarization
    c. TRS %.

Reference Books:

1. Training manual for sugar mills.;Mangal Singh; Somaiya publications Pvt.Ltd. Mumbai.
2. Efficient Management of sugar factories, Mangal Singh, Somaiya publication Pvt.Ltd. Bombay
3. Cane Sugar Manufacture in India, Kulkarni, D.P., The Sugar Technologists Association of India N.Delhi.
4. System of Technical control for cane sugar factories in India; Varma, N.C. The Sugar Technologists Association of India N.Delhi.

Program Name	**BSc in Sugar Science & Technology**		Semester	**III**
Course title	**CHEMISTRY–III (Theory)**			
Course Code	**DSC -9T**		No. of Credits	**03**
Contact hours	**60 Hours (4 Hours/ week)**		Duration of SEA/Exam	**3hours**
Formative Assessment Marks	**20**		Summative Assessment Marks	**80**

UNIT-I :

Structure and Bonding-I **(15 Hrs)**

The ionic bond II: Structures of ionic solids, Radius ratio rules, Calculation of some limiting radius ratio values, Coordination number 3 (planar triangle), Coordination number 4 (tetrahedral and square planar), Coordination number6 (octahedral) close packing.

Classification of ionic structures:

Ionic compounds of the type AX (ZnS, NaCl, CsCI), Ionic compounds of the type AX2 (Calcium fluoride (fluorite) and Rutile structure, Layer structures CdI2, Cadmium iodide structure, Limitations of radius ratio concept, Kapustinskii equation, solvation energy and solubility of ionic solids, Numerical problems

Covalent bond II: The Lewis theory, octet rule, exceptions to the octet rule, Sidgwick- Powell theory. Review of Valence shell electron pair repulsion (VSEPR) theory, Effect of lone pairs, electronegativity, isoelectronic principle, Examples using VSEPR theory: BF3and BF4-, NH3 and NH4+, CIF3, SF4, I3-and I3+, SF6 and IF7. Limitations of VSEPR.

Unit–II **(15 Hrs)**

AROMATIC HYDROCARBONS & ALCOHOLS

AromaticHydrocarbons

Preparation of benzene and alkyl benzenes (Aromatization, cyclic polymerization of ethyne, hydrodealkylation, Wurtz-Fittig reaction). General mechanism for electrophilic aromatic substitution, examples of halogenation, nitration, sulphonation and Friedel-Craft alkylation and acylation reaction. Limitations of Friedel Craft's alkylation. Theory of orientation, explanation on the basis of stability of sigma

complex using electron withdrawing and electron donating groups (explain with the energy profile diagram). Oxidation of side chain (Benzene with alkyl groups –CH3, -CH2CH2CH3 and 1,4- dimethyl benzene)

Alcohols: Synthesis of primary, secondary and tertiary alcohols using Grignard reagent, ester hydrolysis. Reduction of aldehydes and ketones, carboxylic acids and esters.Reactions of alcohols with halo acids, esterification reaction and oxidation of alcohols with PCC, KMnO4, Conc. HNO3 and dichromate salt and Oppenauer oxidation. Diols: Oxidation of diols, Mechanism of Pinacol-Pinacolone rearrangement.

Unit–III Mechanism of Organic Reactions II (15 Hrs)

Carbon-carbon pi bonds: Formation of alkenes and alkynes by elimination reaction. Mechanism of E1, E2, E1cB reaction. Saytzeff and Hofmann eliminations. Addition of HBr to propene, Free radical addition of HBr to propene. Addition of halogens to alkenes-carbocation and halonium ion mechanism. Stereo-specificity of halogen addition. Ozonolysis mechanism - ozonolysis of propene. Diel –Alder reaction and Mechanism of Allylic and benzylic bromination and mechanism in propene, 1-butene, 1-toluene and ethylbenzene.

Nucleophilic substitution at saturated carbon: Mechanism of SN1 and SN2 reactions with suitable examples. Energy profile diagrams, Stereochemistry and factors effecting SN1 and SN2 reactions.

Aromatic Electrophilic substitution reactions: Mechanisms, σ and π complexes, Halogenation, Nitration, Sulphonation, Friedel Crafts alkylation and acylation with their mechanism. Activating and deactivating groups. Orientation influence, Ortho-para ratio. Aromatic nucleophilic substitution reaction: SNAr and Benzyne mechanism with suitable examples.

Unit–IV **(15Hrs)**

First Law of Thermodynamics

Thermodynamic Processes, Reversible and Irreversible Processes, Nature of Heat and Work, Internal Energy, First Law of Thermodynamics, Enthalpy of a System, Work done in isothermal and adiabatic expansion of an ideal gas, Numerical problems, Joule -Thomson Expansion, Relation between Joule-Thomson coefficient and other thermodynamic parameters

Second law of Thermodynamics: Concept of entropy, thermodynamic scale of temperature, Statements of the Second Law of Thermodynamics, molecular interpretation of entropy, Calculation of entropy change for reversible and irreversible processes. Free Energy Functions: Gibbs and Helmholtz energy, Variation of S, G, A with T, V and P, Numerical problems, Free energy change and spontaneity, Gibbs-Helmholtz equation

Third Law of Thermodynamics: Statement of third law, concept of residual entropy, calculation of absolute entropy of molecules

Surface Chemistry

Adsorption: Types of adsorption isotherms. Freundlich adsorption isotherm (only equation), its limitations. Langmuir adsorption isotherm (derivation to be done) and BET equation (derivation not included).

Catalysis : Types of Catalysis and theories with examples (intermediate compound theory and adsorption theory), Michaelis-Menten equation-derivation. Heterogeneous catalysis: surface reactions, unimolecular, bimolecular surface reactions. Autocatalysis with examples. Applications: Design process to removal of toxic compounds from industrial wastewater and treatment of portable water requirements.

Program Name	**BSc in Sugar Science & Technology**	Semester	**III**
Course title	**CHEMISTRY–III:(Practical)**		
Course Code	**DSC -9P**	No. of Credits	**02**
Contact hours	**48 Hours (4 Hours/ week)**	Duration of SEA/Exam	**4 hours**
Formative Assessment Marks	**10**	Summative Assessment Marks	**40**

Experiments:

PRACTICALS

Experiments list

PART-A

1) Colorimetric determination of copper using ammonia solution

2) Colorimetric determination of iron using thiocyanate solution

3) Determination of Rf values of two or three component systems by TLC /Paper Chromatography

4) Separation of different metal ions by paper chromatography/ Solvent extraction of iron using oxine solution **(demonstration)**

PART-B

Qualitative analysis of Organic compounds such as

1) Salicylic acid, p-Nitrobenzoic acid, Antranilicacid, p-Chloro benzoic acid

2) o-Cresol, p-Cresol, Resorcinol, o-Nitrophenol, p-nitophenol

3) o-Nitro aniline, p-Nitroaniline, p-Toluidine, p-Chloroaniline, p-Bromoaniline,

4)Ethyl Salicylate, Salicylaldehyde, Acetophenone, p-Dichlorobenzene, p-Nitrotoluene, Benzamideetc. (At least 6-8compounds to be analysed in a semester)

REFERENCEBOOKS:

1. Organic Reaction Mechanism by V.K.Ahluwalia and R.K.Parashar (Narosa Publishers)
2. Organic Chemistry by S.M.Mukherji, S.P.Sinha and R.K.Kapoor (Narosa Publishers)
3. Morrison R.N and Boyd R.N, Organic Chemistry, Darling Kindersley (India) Pvt. Ltd. (Pearson Education)
4. Finar I.L, Organic Chemistry (VolumeI); Finar I.L (VolumeII) Stereochemistry and the Chemistry of Natural Products.,Dorling Kindersley (India) Pvt. Ltd. (Pearson Education)
5. Kalsi P.S.Stereochemistry, conformation and Mechanism, Newage International
6. Eliel E.Landwilen S.H,Stereochemistry of OrganicCompounds,Wiley,(London).
7. Organic Chemistry Morrison, R.T. & Boyd, R.N., Pearson, 2010.
8. Advanced Organic Chemistry Bahl, A. & Bahl, B.S., S. Chand, 2010.
9. Organic Chemistry Volume-I, II- I. L. Finar, 6th Edition, ELBS London (2004).

SEMESTER IV

Program Name	**BSc in Sugar Science & Technology**	Semester	**IV**
Course title	**Alcohol Technology – I Fermentation Process (Theory)**		
Course Code	**DSC 10-T**	No. of Credits	**03**
Contact hours	**60 Hours (4 Hours/ week)**	Duration of SEA/Exam	**3 Hours**
Formative Assessment Marks	**20**	Summative Assessment Marks	**80**

Unit – I **15 Hours**

Basic terms: Molasses, Total reducing sugar, Fermentable sugar, un- fermentable Sugar, Residual Sugar, Wort, Brix, Specific Gravity, Distillation, Industrial Alcohol, Proof Spirit, Strength of Spirit, Reflux, Vaporization, Saccharification, Scaling, Scrubber, Starch Sucrose rectification, Gelatinization, liquefaction, Under-proof, Over-proof, Fermentation, Strength of spirit, Distillation, Absolute alcohol, Industrial alcohol, Yeast, Thermophilic, Liquefaction, Starch, Sucrose, Re-boiler, Receiver, Rectification, Pasteurization, Organoleptic testing, Micro-organism, Malt, Lactobacillus, Lag phase, Logarithmic phase, Grams stain, Fermentation efficiency, Fermenter, Flocculation, Enzymatic hydrolysis, Disaccharides, Distillate, Cleaning in place system(CIP), Column, Cooper, Bacterial contamination, Acetobacter, Acid washing, antibiotics, Antifoam etc.

Unit – II **15Hours**

Applied Microbiology: Definition of yeast, Taxonomy of yeast, Morphology of yeast, common species of yeast used for alcoholic fermentation, Growth requirement of yeast, Yeast structure and function of cellular components, Metabolic pathway for alcohol production.

Yeast: Isolation of yeast, Propagation of pure yeast culture, Preservation of pure culture, Crab tree effect, Growth Kinetics, Significance of growth curve, lag phase, Log phase, stationary phase, death phase etc,

Unit – III **15 Hours**

Introduction of the fermentation process, Sugar cane molasses production-molasses composition, storage of C-molasses, effects of various components on quality of C-molasses. Factors responsible for reducing the fermentation (F/N) ratio of molasses. Quality standards for final molasses–Brix% / Purity / Ash% / TRS% / Fermentable sugar/Un-fermentable sugar, Spontaneous combustion of molasses.

Unit – IV **15 Hours**

Fermenter: Definition & type of fermenter, Traditional batch, fed-batch & continuous fermentation, Fermentation media, Difference between batch and continuous fermentation, design of fermenters, Fermentation of molasses.

Alcohol production from sugar processing intermediates.

Details of sugar processing intermediates, B-molasses composition, storage of B-molasses, Details of B molasses to ethanol production, Cane Juice & Syrup composition, storage of syrup, Details of Cane juice & syrup to ethanol production, Ethanol blending program in India.

Reference books

1. Industrial Alcohol Technology Handbook, NPCS board of consultant & Engineer
2. Handbook of Alcohol Technology By S. V. Patil
3. Industrial utilization of sugar cane and its Co-products, Manohar Rao, P.J., ISPCK publishers & Distributors Delhi
4. Alcohol Technology by Muthag, Vth edition
5. The Alcohol Textbook – Jacques, T. P. Lyons & D. R. Kelsall
6. A.C. Chatterjee
7. Technical Excise Manual

Program Name	**BSc in Sugar Science & Technology**	Semester	**IV**
Course title	**Alcohol Technology – I Fermentation Process (Practical)**		
Course Code	**DSC 10-P**	No. of Credits	**02**
Contact hours	**48 Hours (4 Hours/ week)**	Duration of SEA/Exam	**4 hours**
Formative Assessment Marks	**10**	Summative Assessment Marks	**40**

8. By-products of the sugar industry – Paturao

Experiments:

1. Isolation and development of a pure yeast culture.
2. Preparation of bacterial culture slides and staining by Gram stain.
3. Determination of fermentable &un-fermentable sugars in molasses.
4. Analysis of juice & syrup – Brix %, RS %, TRS %
5. Analysis of BH Molasses – Brix %, RS %, TRS %
6. Determination of total organic volatile acids in molasses sample.
7. Determination of moisture and ash content of molasses.
8. Determination of the reducing sugar in the molasses sample.
9. Determination of the total reducing sugar in the molasses sample.
10. Determination of sludge content of molasses.

Reference books

1. Industrial Alcohol Technology Handbook, NPCS board of consultant & Engineer
2. Handbook of Alcohol Technology by S. V. Patil
3. Alcohol Technology by Muthag, Vth edition
4. The Alcohol Textbook – Jacques, T. P. Lyons & D. R. Kelsall
5. Alcoholometry – Satyanarayana Rao
6. Handbook of Fermentation and Distillation – A.C. Chatterjee
7. Distillation – H. C. Barron
8. Technical Excise Manual

Program Name	**BSc in Sugar Science & Technology**		Semester	**IV**
Course title	**Sugar Engineering II- INSTRUMENTATION AND AUTOMATION (Theory)**			
Course Code	**DSC 11-T**		No. of Credits	**03**
Contact hours	**60 Hours (4 Hours/ week)**		Duration of SEA/Exam	**3hours**
Formative Assessment Marks	**20**		Summative Assessment Marks	**80**

Unit – I **12 Hours**

Introduction: Introduction to Industrial Instrumentation, Recorders and Monitors, Characteristics of Instruments, static characteristics, error and types of errors, sensitivity, reproductively and dynamic characteristics.

Liquid Level measurement: Liquid level indicators. Direct Method- Hook Type, Sight glass, Float type, Indirect Method – Capacitance level indicator, Radiation level indicator.

Unit – II **12 Hours**

Temperature measurements: High temperature measurements, Mechanical, mercury in glass thermometers, bimetallic thermometers, Electrical, Thermocouples, Seebeck effect, thermoelectric thermometers and pyrometers.

Pressure and vacuum measurements: Units and their conversions, manometers, U-type, Well type and barometer, vacuum gauges, Bourdon Tube, lionization and Pirani gauge.

Unit – III **12 Hours**

Flow measurements: Basic terms such as total flow, volumetric flow, mass flow, viscosity, Reynolds number, types of flow, flow transducers such as orifice plate, pivot tube, anu-bar, venturimeter, variable area flow meter, Rotameter, magnetic flow meter, mass flow meter.

Unit – IV **12 Hours**

Various Auto control systems in sugar industry- Auto cane feed control system, Juice flow control system, pH control system. Evaporator Automation, Pan Automation, Condenser automation, Boiler automation.

Program Name	**BSc in Sugar Science & Technology**	Semester	**IV**
Course title	**Sugar Engineering –II (Practical)**		
Course Code	**DSC 11-P**	No. of Credits	**02**
Contact hours	**48 Hours (4 Hours/ week)**	Duration of SEA/Exam	**4 hours**
Formative Assessment Marks	**10**	Summative Assessment Marks	**40**

Experiments:

1. To study different types of transducer and sensors
2. To study orifice meter
3. To study temperature measurement using thermocouple
4. To study measurement of pressure
5. To study float type liquid level measurement
6. To study magnetic flow meter
7. Calibration of pressure guaze /vacuum gauzes
8. Calibration of temperature sensors
9. To prepare p/I diagram for various automation systems – mill automation, imbibition automation.
10. To prepare p/I diagram for various automation systems –pH control for juice sulphitation, pan automation, sugar weighing system, condenser automation

REFERENCE BOOKS:

1. R. N. Shreve : The Chemical Process Industries (MGH)
2. W. I. Badger and J. T. Bandchero: Introduction to Chemical Engineering (MGH)
3. O. A. Hougen, R. M. Watson and R. A. Ragetz: Chemical Process Principles (Vol. I. II (JW))
4. Industrial Instrumentation and Control by S. K. Singh, Tata McGraw-Hill Publishing Company Limited, New Delhi.
5. Instrumentation by : F.W. Kirk & N.R. Rimboi
6. Theory of Errors by Yardley Beers.

Program Name	**BSc in Sugar Science & Technology**		Semester	**IV**
Course title	**CHEMISTRY- IV (Theory)**			
Course Code	**DSC 12-T**		No. of Credits	**03**
Contact hours	**60 Hours (4 Hours/ week)**		Duration of SEA/Exam	**3hours**
Formative Assessment Marks		**20**	Summative Assessment Marks	**80**

Unit-I Separation methods **(15 Hrs)**

Fundamentals of chromatography: General description, definition, terms and parameters used in chromatography, classification of chromatographic methods, criteria for selection of stationary and mobile phase, nature of adsorbents. Principles of paper, thin layer, column chromatography. Column efficiency, factors affecting the column efficiency, van Deemter's equation and its modern version.

Ion exchange Chromatography

Resins, types with examples-cation exchange and anion exchange resins, mechanism of cation and anion exchange process and applications of ion -exchange chromatography (softening of hard water, separation of lanthanides,).

Ion exchange Chromatography

Resins, types with examples-cation exchange and anion exchange resins, mechanism of cation and anion exchange process and applications of ion -exchange chromatography (softening of hard water, separation of lanthanides,).

Unit – II **(15 Hrs)**

Structure and Bonding-II

Concept of resonance, resonance energy, hybridisation, types of hybridization, sp, sp2, sp3, dsp2, dsp3, d2sp3, sp3d2, with one example each, and energetics of hybridization. Bent's rule, Limitations of Valence Bond Theory.

Molecular Orbital theory-II:

Calculation of bond order, relationship between bond order, bond energy and bond length. Magnetic properties based on MOT. Examples of molecular orbital treatment for homonulcear diatomic molecules: He2, Li2, Be2, B2, C2, N2, N2+, and $O_2$2-

Metallic Bonding:

General properties of metals: Conductivity, Lustre, Malleability and cohesive force, Crystal structures of metals and Bond lengths. Theories of bonding in metals: Free electron theory, Valence bond theory, Molecular orbital or band theory of solids. Prediction of conducting properties of conductors, insulators and semiconductors, extrinsic and intrinsic semiconductors using M.O. theory.

UNIT-III: PHENOLS, ETHERS & CARBONYL COMPOUNDS (15 Hrs)

Phenols: Acidic character, comparative acid strengths of alcohols and phenols, Kolbe's reaction, Claisen rearrangement, Fries rearrangement, Ledrer-Mannase reaction, Reimer-Tiemann reaction. (Mechanism to be discussed for all named reactions)

Ethers: Preparation of ethers, mechanism of Williamson's ether synthesis, mechanism of synthesis of ethers by inter and intra molecular dehydration of alcohols. Reaction of ethers- mechanism of ether cleavage by strong acids. **Epoxides:** Synthesis from alkenes using peroxides, acid and base catalyzed ring opening of epoxides with mechanism and polyether formation. Crown Ethers: Formation and properties (Phase Transfer Catalyst).

Carbonyl Compounds:

Structure of carbonyl compounds, synthesis of aldehydes and ketones by oxidation of alcohols, aldehydes by reduction of acyl chloride, esters, nitriles and ketones from Gillmann's reagent. General mechanism of nucleophilic addition to the carbonyl compounds, mechanism of addition of hydrogen cyanide and hydroxyl amine, addition of alcohol, amines and phosphorus ylids. Acidity of α-hydrogens, mechanism of aldol condensation, crossed aldol condensation, Perkin's reaction, Claisen's condensation,

Dieckman condensation and Darzen's condensation. Reactions of compounds with no α- hydrogens -mechanism of Benzoin condensation and Cannizaro's reaction, crossed Cannizaro's reaction. Reduction of carbonyl groups via Wolf-Kishner reduction and Meerwein-Pondorff Verley reduction.

UNIT-IV Kinetics and Electrochemistry (15 Hrs)

Chemical Kinetics-II

Temperature dependence of reaction rates; Arrhenius equation, activation energy, Numerical problems on Arrhenius equation in calculating energy of activation and rate constants. Collision theory of reaction rates-Lindemann's mechanism, qualitative treatment of the theory of absolute reaction rates. Experimental determination of kinetics of (i) inversion of cane sugar by polarimetric method (ii) spectrophotometric method for the reaction between potassium persulphate and potassium iodide**.**

Electrochemistry–I

Arrhenius theory of electrolytic dissociation. Merits and Demerits, Conductance, Specific conductance, equivalent and molar conductivity and their variation with dilution. Molar conductivity at infinite dilution. Numerical problems.

Kohlrausch's law of independent migration of ions and its applications, Debye-Hückel-Onsager equation. Ionic mobility and its determinations, transference numbers and their relation to ionic mobility's, determination of transference numbers using Hittorf and Moving Boundary methods.

Applications of conductance measurement: (i) degree of dissociation of weak electrolytes (ii) ionic product of water (iii) solubility and solubility product of sparingly soluble salts (iv) conductometric titrations (acid base titrations only) and (v) Hydrolysis constants of salts. Numerical problems**.**

Program Name	**BSc in Sugar Science & Technology**		Semester	**IV**
Course title	**CHEMISTRY–IV:(Practical)**			
Course Code	**DSC -12P**		No. of Credits	**02**
Contact hours	**48 Hours (4 Hours/ week)**		Duration of SEA/Exam	**4 hours**
Formative Assessment Marks	**10**		Summative Assessment Marks	**40**

Experiments:

PRACTICALS

Experiments list

Part A- Inorganic Chemistry Practical

Qualitative semi-microanalysis of mixtures containing 2anions and 2 cations. Emphasis should be given to the understanding of different reactions.

The following cations and anions are suggested.

Cations:

NH_4^+, Pb^{2+}, Bi^{3+}, Cu^{2+}, Al^{3+}, Fe^{3+}, Co^{2+}, Cr^{3+}, Ni^{2+}, Zn^{2+}, Mn^{2+}, Ba^{2+}, Ca^{2+}, Sr^{2+}, Mg^{2+}, Na^+, K^+.

Anions: CO_3^{2-}, Cl^-, Br^-, I^-, NO_3^-, SO_4^{2-}, S^{2-} (Sulphide)

Spot tests and flame tests to be carried out wherever possible.

Part B- Physical Chemistry Practical

1. Determination of the enthalpy of neutralization of a strong acid with strong base.
2. Determination of velocity constant for acid catalysed hydrolysis of methylacetate.
3. Determination of equivalent conductivity of strong electrolyte and verification of DHO equation.
4. Determination of dissociation constant of weak acid by conductivity method.
5. Conductometric titration of strong acid and strong base.
6. Conductometric titration of weak acid and strong base.

REFERENCE BOOKS:

1. Peter Atkins & Julio De Paula, Physical Chemistry, 9th Ed., Oxford University Press(2010)
2. GWCastellan,PhysicalChemistry,4thEd.,Narosa(2004)
3. RGMortimer,PhysicalChemistry3rdEd.,Elsevier:Noida,UP(2009)
4. B R Puri, L R Sharma and M S Pathania, Principal of Physical Chemistry, Vishal Publishing Co.
5. B S Bahl, G D Tuli and ArunBahl, Essentials of Physical chemistry, S Chand & Company Ltd.
6. A S Negi and S C Anand, A textbook of Physical Chemistry, New Age International Publishers.
7. BN Bajpai, Advanced Physical chemistry, S Chand and Company ltd.
8. R L Madan, Chemistry for Degree Students, Semester I, II, III and IV, S Chand and Company Ltd.
10. P L Soni, O P Dharmarha and U N Dash, Textbook of Physical Chemistry, Sultan Chand and Sons.
11. Organic Chemistry Morrison, R.T. & Boyd, R.N., Pearson, 2010.
12. Advanced Organic Chemistry Bahl, A. & Bahl, B.S., S. Chand, 2010.
13. Organic Chemistry Volume-I, II- I. L. Finar, 6th Edition, ELBS London (2004).

Program Name	**BSc in Sugar Science & Technology** **B.Sc. in Sugar Science & Technology**		Semester Semester:	**III** **III**
Course title	**Compulsory-2 Practical knowledge Skill- (Practical)**			
Course Code		No. of Credits		**02**
Contact hours	**30 Hours (2 Hours/ week)**	Duration of SEA/Exam		**3 hours**
Formative Assessment Marks	**10**	Summative Assessment Marks		**40**

Experiments:

1. Water Analysis: pH, alkalinity, hardness, chlorites EC, nutrients (3P)
2. Determination of Brix, Specific Gravity, pH of molasses
3. Determination of moisture and ash content of molasses.
4. Determination of total solids and suspended solids of molasses.
5. Estimation of calcium content of molasses by EDTA method.
6. Determination of sludge content of molasses

Reference Books:

1. Industrial Alcohol technology Handbook, NPCS board of consultant & Engineer
2. Hand book of Alcohol Technology By S. V. Patil
3. Alcohol Technology By Muthag, Vth eddition
4. The Alcohol Textbook – Jacques, T. P. Lyons & D. R. Kelsall
5. Alcoholometry – Satyanarayana Rao
6. Handbook of Fermentation and Distillation – A.C. Chatterjee
7. Distillation – H. C. Barron
8. Technical Excise Manual

Course title	**Elective:1 INDUSTRIAL SAFETY(Theory) 3rd Semester**		
Program Name	**BSc in Sugar Science & Technology**	Semester	**IV**
Course Code		No. of Credits	**02**
Contact hours	**30 Hours (2 Hours/ week)**	Duration of SEA/Exam	**1:30 hours**
Formative Assessment Marks	**10**	Summative Assessment Marks	**40**

UNIT I 15 hours

Occupation, Safety and Management: Introduction,Terms and definitions,Occupational Safety, Health and Environmental Safety, Management – Principles and practices, Role of Management, organization and administration in Industrial Safety, Classifications of accidents: Fire and explosion, Electrical accidents, Chemical accidents, Accidents from civil works etc. Human factors contributing to accident, Objectives of safety management, Planning: Definition, purpose, nature, scope and procedure. Management by objectives and its role in Safety, Health and Management (SHE).

UNIT II 15 hours

Monitoring for Safety, Health and Environment: Environmental hazards: Introduction, definitions, pollution, energy, man and environment law of conservation energy. Occupational health, Care of scheme, back ache, effect of dust on lungs, air borne dust, diabetes, noise in industry etc.. First aid: principles, training, general rules, shocks, control of bleeding, burns and scalds, heart attack etc. Safety and Govt. role: Objectives, employee's state insurance act, work men compensation act.

Reference book

1. R.K. Jain and Sunil S. Rao "Industrial safety, Health and Environment management system"
2. Basudev Panda "Industrial Safety, Health Environment and Security".
3. K. S. N. Raju "Chemical Process Industry Safety".
4. Akhil Kumar Das "Principles of Industrial Safety Management"
5. L. M. Deshmukh "Industrial Safety Management".
6. Laird Wilson, Doug Mccutcheon, Marilyn Buchanan "Industrial Safety and Risk Management".
7. Amit Gupta "Industrial Safety and Environment".
   Prekash Sesha "Manual of Fire Safety".

Course title	**Compulsory-2 Practical knowledge Skill (Practical)**		
Course Code		No. of Credits	**02**
Contact hours	**30 Hours (2 Hours/ week)**	Duration of SEA/Exam	**3hours**
Program Name	**B.Sc. in Sugar Science & Technology**	Semester	**IV**
Formative Assessment Marks	**10**	Summative Assessment Marks	**40**

Experiments:

1. Qualitative Analysis of Carbohydrates: -
   a) Glucose
   b) Fructose
   c) Sucrose
   d) Lactose
   e) Galactose
2. Determination Of Total Phenolic Content in Sugarcane Juice
3. Separation Of Sugarcane Plant Pigments by Paper Chromatography.
4. Determination Of Titrable Acidity in Sugarcane Juice
5. Determination Of Melting Point of Sucrose and Boiling Point Of Different Concentrations Of Sugar Solutions
6. Determination Of Reducing Sugar By 3,5-Dinitrosalicylic Acid Method.

Reference Books

1. Garner, D., Crisosto, C H., Wiley, P and Crisosto, G M. Measurement of pH and Titratable Acidity. http://fruitandnuteducation.ucdavis.edu/files/162035.pdf
2. Harris, Georgia L (2012). Selected procedures for volumetric calibrations. National Institute of Standards and Technology, U S Department of Commerce, USA.
3. http://davjalandhar.com/dbt/chemistry/SOP%20LabManuals/B.Sc.%20SEM%20I.pdf
4. http://www.kau.edu.sa/GetFile.aspx?id=156660&fn=bioc_211(lab7).pdf
5. https://www.colby.edu/chemistry/PChem/lab/InversionSucrose.pdf
6. ICUMSA Method GS 7-19 (1994). The Determination of Calcium and Magnesium in Cane Juice and Syrup, by EDTA Titration.
7. Jayaraman, J (1981). Laboratory manual in biochemistry. New Age International Ltd., India
8. Kamboj, P C (2008). University practical chemistry. Vishal Publishing Company, India.

Course title	**Elective:2 ANALYTICAL INSTRUMENTATION (Theory) 4th Semester**		
Course Code		No. of Credits	**02**
Contact hours	**30 Hours (2 Hours/ week)**	Duration of SEA/Exam	**1:30 hours**
Formative Assessment Marks	**10**	Summative Assessment Marks	**40**

Unit-I **15 Hours**

pH and Conductivity measurements: Introduction sensors, Electro analytical Sensors, different types of sensor electrodes, pH meter, standardization and pH measurements, conductivity solutions, specific and equivalent conductivity, equivalent conductivity at infinite dilution, measurement of conductivity/resistivity of solution, Conductometers, conductivity cell applications.

Spectroscopy: General principles of absorption spectroscopy, theory of Colorimetry, Beers & lambert's Law, Instrumentation of Photoelectric Colorimeter and applications.

Unit-II **15 Hours**

Flame Photometry: General discussion and elementary theory, Instrumentation of flames photometer, monochromators, detectors and applications.

Polarimetry: Introduction, plane polarized light, optical activity, Instrumentation of Polarimeter, types of polarimeter, Industrial polarimeter, white lamp single wedge and double wedge polarimeter, and other applications in sugar technology.

Refractometry: Introduction, Snell's law, specific refraction, molar refraction, Hand Refractometer, Abbe's Refractometer, experimental techniques, and applications.

Reference Books:

1. Vogel's Textbook of Quantitative Inorganic revised by J. Bassett et al.
2. Instrumental Methods of Chemical Analysis by H. Kaur.
3. Instrumental methods of analysis by Strobel.
4. Practical Physical Chemistry by Findley.
5. Instrumental methods of chemical analysis by Bhal and Tuli.

SEMESTER III

Program Name	**BSc in Sugar Science & Technology**	Semester	**III**
Course title	**CHEMISTRY–III (Theory)**		
Course Code	**DSC -9T**	No. of Credits	**03**
Contact hours	**60 Hours (4 Hours/ week)**	Duration of SEA/Exam	**3hours**
Formative Assessment Marks	**20**	Summative Assessment Marks	**80**

UNIT-I :

Structure and Bonding-I **(15 Hrs)**

The ionic bond II: Structures of ionic solids, Radius ratio rules, Calculation of some limiting radius ratio values, Coordination number 3 (planar triangle), Coordination number 4 (tetrahedral and square planar), Coordination number6 (octahedral) close packing.

Classification of ionic structures:

Ionic compounds of the type AX (ZnS, NaCl, CsCI), Ionic compounds of the type AX2 (Calcium fluoride (fluorite) and Rutile structure, Layer structures CdI2, Cadmium iodide structure, Limitations of radius ratio concept, Kapustinskii equation, solvation energy and solubility of ionic solids, Numerical problems

Covalent bond II: The Lewis theory, octet rule, exceptions to the octet rule, Sidgwick-Powell theory. Review of Valence shell electron pair repulsion (VSEPR) theory, Effect of lone pairs, electronegativity, isoelectronic principle, Examples using VSEPR theory: BF3and BF4-, NH3 and NH4+, CIF3, SF4, I3-and I3+, SF6 and IF7. Limitations of VSEPR.

Unit–II **(15 Hrs)**

Aromatic hydrocarbons & alcohols

Aromatic Hydrocarbons

Preparation of benzene and alkyl benzenes (Aromatization, cyclic polymerization of ethyne, hydrodealkylation, Wurtz-Fittig reaction). General mechanism for electrophilic aromatic substitution, examples of halogenation, nitration, sulphonation and Friedel-Craft alkylation and acylation reaction. Limitations of Friedel Craft's alkylation. Theory of orientation, explanation on the basis of stability of sigma complex using electron withdrawing and electron donating groups (explain with the energy profile diagram). Oxidation of side chain (Benzene with alkyl groups –CH3, -CH2CH2CH3 and 1,4- dimethyl benzene)

Alcohols: Synthesis of primary, secondary and tertiary alcohols using Grignard reagent, ester hydrolysis. Reduction of aldehydes and ketones, carboxylic acids and esters. Reactions of alcohols with halo acids, esterification reaction and oxidation of alcohols with PCC, $KMnO_4$, Conc. HNO_3 and dichromate salt and Oppenauer oxidation. Diols: Oxidation of diols, Mechanism of Pinacol-Pinacolone rearrangement.

Unit–III

Mechanism of Organic Reactions II (15 Hrs)

Carbon-carbon pi bonds: Formation of alkenes and alkynes by elimination reaction. Mechanism of E1, E2, E1cB reaction. Saytzeff and Hofmann eliminations. Addition of HBr to propene, Free radical addition of HBr to propene. Addition of halogens to alkenes-carbocation and halonium ion mechanism. Stereo-specificity of halogen addition. Ozonolysis mechanism - ozonolysis of propene. Diel –Alder reaction and Mechanism of Allylic and benzylic bromination and mechanism in propene, 1-butene, 1-toluene and ethylbenzene.

Nucleophilic substitution at saturated carbon: Mechanism of SN1 and SN2 reactions with suitable examples. Energy profile diagrams, Stereochemistry and factors effecting SN1 and SN2 reactions.

Aromatic Electrophilic substitution reactions: Mechanisms, σ and π complexes, Halogenation, Nitration, Sulphonation, Friedel Crafts alkylation and acylation with their mechanism. Activating and deactivating groups. Orientation influence, Ortho-para ratio. Aromatic nucleophilic substitution reaction: SNAr and Benzyne mechanism with suitable examples.

Unit–IV (15Hrs)

First Law of Thermodynamics

Thermodynamic Processes, Reversible and Irreversible Processes, Nature of Heat and Work, Internal Energy, First Law of Thermodynamics, Enthalpy of a System, Work done in isothermal and adiabatic expansion of an ideal gas, Numerical problems, Joule -Thomson Expansion, Relation between Joule-Thomson coefficient and other thermodynamic

parameters

Second law of Thermodynamics

Concept of entropy, thermodynamic scale of temperature, Statements of the Second Law of Thermodynamics, molecular interpretation of entropy, Calculation of entropy change for reversible and irreversible processes. Free Energy Functions: Gibbs and Helmholtz energy, Variation of S, G, A with T, V and P, Numerical problems, Free energy change and spontaneity, Gibbs-Helmholtz equation

Third Law of Thermodynamics

Statement of third law, concept of residual entropy, calculation of absolute entropy of molecules

Surface Chemistry

Adsorption

Types of adsorption isotherms. Freundlich adsorption isotherm (only equation), its limitations. Langmuir adsorption isotherm (derivation to be done) and BET equation (derivation not included).

Program Name	**BSc in Sugar Science & Technology**	Semester	**III**
Course title	**CHEMISTRY–III: (Practical)**		
Course Code	**DSC -9P**	No. of Credits	**02**
Contact hours	**48 Hours (4 Hours/ week)**	Duration of SEA/Exam	**4 hours**
Formative Assessment Marks	**10**	Summative Assessment Marks	**40**

Experiments:

PRACTICALS

Experiments list

PART-A Preparation of Organic compounds

1. Nitration- Nitration of acetanilide to p-nitro acetanilide.
2. Bromination- Acetanilinde to p-bromoacetanilide.
3. Hydrolysis- Benzamide to benzoic acid.
4. Oxidation- Benzaldehyde to benzoic acid.
5. Preparation of urea formaldehyde resin.
6. Nitration- Nitration of salicylic acid using calcium nitrate and acetic acid

PART-B Determination of Organic compounds

1. Determination of phenol by bromination method
2. Determination of aniline by bromination method.
3. Determination of acetamide by hydrolysis method.
4. Determination of ethyl benzoate by hydrolysis method.
5. Determination of aspirin in the tablet by hydrolysis method.
6. Determination of formaldehyde using sodium sulphite.

Note: In the preparation experiment, student has to write mechanism of reactions, calculation of quantitative yield, determination of melting point and to perform recrystallization.

Distribution of marks for preparation experiments: (15 marks.) Calculation of theoretical yield – 03 marks, observed yield -10 marks, M.P- 02 marks,

Deduction of marks for observed yield: Less than 10% - 10 marks, 11-15% - 8 marks, 16-20% - 6 marks, 21-25 % - 4 marks & above 25% - 2 marks.

Distribution of marks for determination experiments: (15 marks.)

Accuracy - 10(5+5) marks, Technique and presentation - 02 marks, Reactions and Calculations - 03 marks. Journal -05marks, Viva: 05 marks Total = 40 marks

Deduction of marks for accuracy : : ±0.2 CC – 5 marks, ± 0.4 CC- 04 marks, ±0.6 CC- 03 marks, ±0.8 CC - 02 marks. Above ±1.0 CC -01 mark.

REFERENCE BOOKS:

1. Organic Reaction Mechanism by V.K.Ahluwalia and R.K.Parashar (Narosa Publishers)
2. Organic Chemistry by S.M.Mukherji, S.P.Sinha and R.K.Kapoor (Narosa Publishers)
3. Morrison R.N and Boyd R.N, Organic Chemistry, Darling Kindersley (India) Pvt. Ltd. (Pearson Education)
4. Finar I.L, Organic Chemistry (VolumeI); Finar I.L (VolumeII) Stereochemistry and the Chemistry of Natural Products.,Dorling Kindersley (India) Pvt. Ltd. (Pearson Education)
5. Kalsi P.S.Stereochemistry, conformation and Mechanism, Newage International
6. Eliel E.Landwilen S.H,Stereochemistry of OrganicCompounds,Wiley,(London).
7. Organic Chemistry Morrison, R.T. & Boyd, R.N., Pearson, 2010.
8. Advanced Organic Chemistry Bahl, A. & Bahl, B.S., S. Chand, 2010.
9. Organic Chemistry Volume-I, II- I. L. Finar, 6th Edition, ELBS London (2004).

Program Name	**BSc in Sugar Science & Technology**		Semester	**IV**
Course title	**CHEMISTRY- IV (Theory)**			
Course Code	**DSC 11-T**		No. of Credits	**03**
Contact hours	**60 Hours (4 Hours/ week)**		Duration of SEA/Exam	**3hours**
Formative Assessment Marks	**20**		Summative Assessment Marks	**80**

SEMESTER IV

Unit-I Separation methods **(15 Hrs)**

Chromatography:

Paper Chromatography: Theory, Rf value, and its calculations, techniques and applications. Separation of Pb2+, Ag+ and Hg2+.

Column Chromatography: Theory, techniques and applications. Separation of methylene blue and malachite green.

Ion Exchange Chromatography: Principle, types of ion exchangers and applications. Separation of amino acids from its mixture. **Ion exchange Chromatography**

Industrial Chemistry:

Glass and Cement: General properties, silicate and non-silicate glasses and manufacture. Composition, properties and applications of soda lime glass, lead glass, armored glass, safety glass, borosilicates glass, coloured glass, photosensitive glass. Classification with properties & manufacture of Portland cement. Setting and hardening of cement. RCC and quick setting cements.

Ion exchange Chromatography

Soaps and detergents: Composition, types & preparation of soaps & detergents (sodium alkyl sulphate, sodium alkyl benzene sulphonates). Comparison of soaps and detergents.

Micelles: Mechanism of cleansing action of soap and detergents. Detergents builders and additives (only examples).

Unit – II **(15 Hrs)**

Structure and Bonding-II

Concept of resonance, resonance energy, hybridisation, types of hybridization, sp, sp^2, sp^3, dsp^2, dsp^3, d^2sp^3, sp^3d^2, with one example each, and energetics of hybridization. Bent's rule, Limitations of Valence Bond Theory.

Molecular Orbital theory-II:

Calculation of bond order, relationship between bond order, bond energy and bond length. Magnetic properties based on MOT. Examples of molecular orbital treatment for homonulcear diatomic molecules: He_2, Li_2, Be_2, B_2, C_2, N_2, N_2+, and $O_2$2-

Metallic Bonding:

General properties of metals: Conductivity, Lustre, Malleability and cohesive force, Crystal structures of metals and Bond lengths. Theories of bonding in metals: Free electron theory, Valence bond theory, Molecular orbital or band theory of solids. Prediction of conducting properties of conductors, insulators and semiconductors, extrinsic and intrinsic semiconductors using M.O. theory.

UNIT-III : Phenols, ethers & carbonyl compounds (15 Hrs)

Phenols: Acidic character, comparative acid strengths of alcohols and phenols, Kolbe's reaction, Claisen rearrangement, Fries rearrangement, Ledrer-Mannase reaction, Reimer-Tiemann reaction. (Mechanism to be discussed for all named reactions)

Ethers: Preparation of ethers, mechanism of Williamson's ether synthesis, mechanism of synthesis of ethers by inter and intra molecular dehydration of alcohols. Reaction of ethers- mechanism of ether cleavage by strong acids. **Epoxides:** Synthesis from alkenes using peroxides, acid and base catalyzed ring opening of epoxides with mechanism and polyether formation. Crown Ethers: Formation and properties (Phase Transfer Catalyst).

Carbonyl Compounds:

Structure of carbonyl compounds, synthesis of aldehydes and ketones by oxidation of alcohols, aldehydes by reduction of acyl chloride, esters, nitriles and ketones from Gillmann's reagent. General mechanism of nucleophilic addition to the carbonyl

compounds, mechanism of addition of hydrogen cyanide and hydroxyl amine, addition of alcohol, amines and phosphorus ylids. Acidity of α-hydrogens, mechanism of aldol condensation, crossed aldol condensation, Perkin's reaction, Claisen's condensation, Dieckman condensation and Darzen's condensation. Reactions of compounds with no α- hydrogens -mechanism of Benzoin condensation and Cannizaro's reaction, crossed Cannizaro's reaction. Reduction of carbonyl groups via Wolf-Kishner reduction and Meerwein-Pondorff Verley reduction.

UNIT-IV Kinetics and Electrochemistry (15 Hrs)

Chemical Kinetics-II

Temperature dependence of reaction rates; Arrhenius equation, activation energy, Numerical problems on Arrhenius equation in calculating energy of activation and rate constants. Collision theory of reaction rates-Lindemann's mechanism, qualitative treatment of the theory of absolute reaction rates. Experimental determination of kinetics of (i) inversion of cane sugar by polarimetric method (ii) spectrophotometric method for the reaction between potassium persulphate and potassium iodide**.**

Electrochemistry–I

Arrhenius theory of electrolytic dissociation. Merits and Demerits, Conductance, Specific conductance, equivalent and molar conductivity and their variation with dilution. Molar conductivity at infinite dilution. Numerical problems.

Kohlrausch's law of independent migration of ions and its applications, Debye-Hückel-Onsager equation. Ionic mobility and its determinations, transference numbers and their relation to ionic mobility's, determination of transference numbers using Hittorf and Moving Boundary methods.

Applications of conductance measurement: (i) degree of dissociation of weak electrolytes (ii) ionic product of water (iii) solubility and solubility product of sparingly soluble salts (iv) conductometric titrations (acid base titrations only) and (v) Hydrolysis constants of salts. Numerical problems**.**

Program Name	**BSc in Sugar Science & Technology**	Semester	**IV**
Course title	**CHEMISTRY–IV:(Practical)**		
Course Code	**DSC -11P**	No. of Credits	**02**
Contact hours	**48 Hours (4 Hours/ week)**	Duration of SEA/Exam	**4 hours**
Formative Assessment Marks	**10**	Summative Assessment Marks	**40**

Experiments:

PRACTICALS

Experiments list

Part A- Inorganic Chemistry Practicals

Qualitative semi-microanalysis of mixtures containing 2anions and 2 cations. Emphasis should be given to the understanding of different reactions.

The following cations and anions are suggested.

Cations:

NH_4^+, Pb^{2+}, Bi^{3+}, Cu^{2+}, Al^{3+}, Fe^{3+}, Co^{2+}, Cr^{3+}, Ni^{2+}, Zn^{2+}, Mn^{2+}, Ba^{2+}, Ca^{2+}, Sr^{2+}, Mg^{2+}, Na^+, K^+.

Anions: CO_3^{2-}, Cl^-, Br^-, I^-, NO_3^-,, SO_4^{2-}, S^{-2}(Sulphide)

Spot tests and flame tests to be carried out wherever possible.

Part B- Physical Chemistry Practicals

1. Determination of the enthalpy of neutralization of a strong acid with strong base.
2. Determination of velocity constant for acid catalysed hydrolysis of methylacetate.
3. Determination of equivalent conductivity of strong electrolyte and verification of DHO equation.
4. Determination of dissociation constant of weak acid by conductivity method.
5. Conductometric titration of strong acid and strong base.
6. Conductometric titration of weak acid and strong base.

REFERENCE BOOKS:

1. Peter Atkins & Julio De Paula, Physical Chemistry, 9th Ed., Oxford University Press(2010)
2. GWCastellan,PhysicalChemistry,4thEd.,Narosa(2004)
3. RGMortimer,PhysicalChemistry3rdEd.,Elsevier:Noida,UP(2009)
4. B R Puri, L R Sharma and M S Pathania, Principal of Physical Chemistry, Vishal Publishing Co.
5. B S Bahl, G D Tuli and ArunBahl, Essentials of Physical chemistry, S Chand & Company Ltd.
6. A S Negi and S C Anand, A textbook of Physical Chemistry, New Age International Publishers.
7. BN Bajpai, Advanced Physical chemistry, S Chand and Company ltd.
8. R L Madan, Chemistry for Degree Students, Semester I, II, III and IV, S Chand and Company Ltd.
10. P L Soni, O P Dharmarha and U N Dash, Textbook of Physical Chemistry, Sultan Chand and Sons.
11. Organic Chemistry Morrison, R.T. & Boyd, R.N., Pearson, 2010.
12. Advanced Organic Chemistry Bahl, A. & Bahl, B.S., S. Chand, 2010.
13. Organic Chemistry Volume-I, II- I. L. Finar, 6th Edition, ELBS London (2004).

RANI CHANNAMMA UNIVERSITY, BELAGAVI

CURRICULUM FRAMEWORK FOR UNDER GRADUATE COURSE

STRUCTURE & SYLLABUS OF BACHELOR OF SCIENCE

SUGAR SCIENCE AND TECHNOLOGY

SEP 5th to 6th semesters

w.e.f

Academic year 2026-27 onwards

Submitted by

Chairman,

Board of Studies (UG),

Bachelor of Science,

Rani Channamma University, Belagavi

Semester-V								
Sl. No.	**Course Code**	**Course**	**No. of Teaching hours per week**	**Total of Internal Assessment marks**	**Final Examination Marks**	**Total marks**	**Exam Hours**	**Credits**
1	DSC-13T	EQUIPMENT CAPACITY CALCULATION	4	20	80	100	3 Hours	3
2	DSC-14T	Sugar Processing-IV: CENTRIFUGATION	4	20	80	100	3 Hours	3
3	DSC-14P	Sugar Processing-IV: Practical	4	10	40	50	4 Hours	2
4	DSC-15T	WATER AND EFFLUENT TREATMENT	4	20	80	100	3 Hours	3
5	DSC-16T	Alcohol Technology-II: DISTILLATION AND SPENTWASH HANDLING.	4	20	80	100	3 Hours	3
6	DSC-16P	Alcohol Technology-II: Practical	4	10	40	50	4 Hours	2
7	DSC-17T	CHEMISTRY- VA	4	20	80	100	3 Hours	3
8	DSC-18T	CHEMISTRY- VB	4	20	80	100	3 Hours	3
9	DSC-18P	CHEMISTRY- V Practical	4	10	40	50	4 Hours	2
10		Compulsory-2 Practical Knowledge Skill	2	10	40	50	1:30 Hours	2
						800		26

Semester-VI								
Sl. No.	**Course Code**	**Course**	**No. of Teaching hours per week**	**Total of Internal Assessment marks**	**Final Examination Marks**	**Total marks**	**Exam Hours**	**Credits**
1	DSC-19T	INDUSTRIAL MANAGEMENT	4	20	80	100	3 Hours	3
2	DSC-20T	ALLIED SUGAR MANUFACTURING	4	20	80	100	3 Hours	3
3	DSC-20P	ALLIED SUGAR MANUFACTURING-Practical	4	10	40	50	4 Hours	2
4	DSC-21T	Sugar Engineering-III: BASICS OF CHEMICAL ENGINEERING	4	20	80	100	3 Hours	3
5	DSC-22T	SUGAR INDUSTRY CO-PRODUCTS	4	20	80	100	3 Hours	3
6	DSC-22P	SUGAR INDUSTRY CO-PRODUCTS-Practical	4	10	40	50	4 Hours	2
7	DSC-23T	CHEMISTRY- VIA	4	20	80	100	3 Hours	3
8	DSC-24T	CHEMISTRY- VIB	4	20	80	100	3 Hours	3
9	DSC-24P	CHEMISTRY- VI Practical	4	10	40	50	4 Hours	2
10		Compulsory-2 Practical Knowledge Skill	2	10	40	50	1:30 Hours	2
						800		26

SEMESTER-V

Program Name	**B.Sc. in Sugar Science & Technology**	Semester	**V**
Course title	**EQUIPMENT CAPACITY CALCULATION (Theory)**		
Course Code	**DSC 13-T**	No. of Credits	**03**
Contact hours	**60 Hours (4 Hours/ week)**	Duration of SEA/Exam	**3 Hours**
Formative Assessment Marks	**20**	Summative Assessment Marks	**80**

Course Pre-requisite(s):

Course Objectives: Students learn about:

1. Different types of equipments used in sugar industry.
2. Construction and working of various equipments.
3. Basic formula and principles for equipments design.
4. Construction details of different types of vacuum pans used for sugar crystallization.
5. Different grades of massecuites boiled during sugar processing.

Course Objectives: Course specific outcomes:

After the completion of this course, the student would be able to:

1. Understand objectives juice heating equipments.
2. Able to know various terms and definitions like retention time and boiling time and heating surface. Know the working of different clarifying equipments and their significance.
3. Understand the Heating surface and evaporation coefficient of evaporator.
4. Know the different unit operations like massecuite boiling time, strike time and heating surface to volume ratio.
5. Understand the capacity calculation of centrifugal machines.
6. Costing of Sugar, Distillery/ Ethanol and Co-generation including DPR.

Contents:

Unit – I **15 Hours**

Introduction: Selection of site for a sugar factory - economics of factory location, types of layout, land required for factory, requirement of cane area, electricity & water requirement.

Juice heater – Calculations for HS, number of tubes per pass, juice inlet/out let pipe sizes, exhaust /Vapour inlet sizes, condensate outlet sizes, condensate extraction arrangement

Evaporator – Calculations for HS, number of tubes, juice inlet/out let pie sizes, exhaust /Vapour inlet/outlet sizes, condensate outlet sizes, condensate extraction arrangement, vapour bleeding

Unit – II **15 Hours**

Vapour Bleeding System: Use of steam table, Vapour bleeding calculations for Quadruple & quintuple effect, Dessin's formulas, Specific evaporation coefficient calculation & importance, estimation of evaporation rate based on brix data, BPR and its calculations

Juice Clarification: Juice piping sizes, Shock liming time calculation, juice sulphiter sizing, clarifier sizing, vacuum filter sizing, sulphur burner sizing

Juice & evaporator section: Capacity calculations for standard 5000 TCD sugar plant – raw juice to syrup

Unit – III **15 Hours**

Pan & crystallizers – Calculations for HS, number of tubes, graining volume, strike level, S/V ratio, vapour inlet /outlet, capacity calculations for crystallizers, Number of pans /Types of crystallizers, low grade/ crystallizers / storage tanks required for 5000 TCD capacity.

Cooling and Condensing– Calculations for water requirement for condensers, number of nozzles for spray pond, spray pond layout, piping size calculations for cooling & condensing system, Idea about cooling.

Unit – IV **15 Hours**

Centrifugals: Capacity calculations for high & low grade centrifugals, Molasses & massecuite pumps calculations, Molasses storage tank capacity calculations. Different types of centrifugal machines.

Sugar handling equipment's: capacity calculations for sugar hopper, sugar elevator, sugar grader, sugar silo, dry seed conveying system and related accessories , Normal specifications for 5000 TCD sugar plant.

REFERENCE BOOKS:

1. Principles of sugar technology, Honig Pieter, Elesevier publishing company Amsterdam
2. Hand book of Cane Sugar Engineering, Hugot e., Elesevier Science publishing Co.Inc. New York.
3. Cane Sugar Manufacture in India, Kulkarni, D.P., The Sugar Technologists Association of India N.Delhi.
4. Sugar Technology (Capacity), Dr. G. M. Jenekar.
5. Machinery and Equipment of the cane sugar factory, Tromp, L.A., Norman Rodger, 7 & 8 Idol Lane.
6. Introduction to cane Sugar Technology, Jenkins, Q.H., Elesevier scientific publishing company Amsterdam.

Program Name	**B.Sc. in Sugar Science & Technology**	Semester	**V**
Course title	**Sugar Processing-IV: CENTRIFUGATION (Theory)**		
Course Code	**DSC 14-T**	No. of Credits	**03**
Contact hours	**60 Hours (4 Hours/ week)**	Duration of SEA/Exam	**3hours**
Formative Assessment Marks	**20**	Summative Assessment Marks	**80**

Course Pre-requisite(s):

Course Objectives: Students learn about:

1. Different types of crystallizers adopted for cooling crystallization of massecuite.
2. Construction and working of batch and continuous crystallizer.
3. Gravity factor for centrifugal separation of molasses by massecuite.
4. Construction and working of batch centrifugal machine.
5. Continuous centrifugal machine construction and working.
6. Sugar handling equipments role and work.

Course Objectives: Course specific outcomes:

After the completion of this course, the student would be able to:

1. Important of cooling crystallization.
2. Working and maintenance of different batch and continuous type crystallizers.
3. Operating knowledge of batch centrifugal machine.
4. Understand the factors affecting the performance of batch centrifugal machine.
5. Know the construction and working of continuous centrifugal machine.
6. Understand the role and working of sugar handling equipments.

Contents:-

Unit – I **15 Hours**

Crystallizers: Batch type Crystallizers: crystallization in motion and at rest, Air cooling and water cooling, different types of crystallizers, Construction details of Batch type crystallisers, Vacuum Crystallisers: Concept, use, construction and working details, cooling water requirement, cooling duration.

Continuous Crystallizers: Vertical continuous crystallisers - concept, use, different types & construction details, Batch crystallisers continuous operation - concept, use, different types & construction details.

Unit – II **15 Hours**

Cooling and reheating of massecuite, growth of crystals, molasses exhaustion, temperature of saturation, saturoscope, massecuite reheating different methods of reheating, reheating their advantages and disadvantages.

Modern batch type Centrifugal machines : Definition of centrifugal force/centripetal force, Gravity factor, Construction and working, Monitor casing, working and backing screen, basket, plough, massecuite feeding, molasses chamber, different speeds, water wash nozzles, molasses separator, bottom hood etc.

Unit – III **15 Hours**

Factors affecting performance of batch type centrifugal machine: Influence of process & operational parameters in centrifugal machine design, Purging rate, Purging efficiency, importance of washing in batch centrifugals, Dilution of massecuite and quantity of water used , Reheating of massecuite, Sequential operation of the fully automatic recycling self-discharging centrifugal machine, Modern flat bottom fully automatic centrifugal machine. Operational trouble shooting.

Unit – IV **15 Hours**

Continuous centrifugal machines: Construction and working, Monitor casing, working and backing screen, basket, massecuite feeding, molasses chamber, water wash nozzles arrangement etc, different designs of modern continuous machines.

Sugar handling system: Grass hopper, Horizontal & rotary sugar dryer, Fluidized bed hoppers, Sugar elevator, Sugar Screening equipment's: Sugar Graders- Rotary type, Grass hopper type, Magnetic or vibrating type. Different grades of sugar.

Reference Books:

1. Principles of sugar technology, Honig Pieter, Elesevier publishing company Amsterdam
2. Handbook of Cane Sugar Engineering, Hugot., Elesevier Science publishing Co. Inc. NewYork.
3. Training manual for sugar mills. Mangal Singh; Somaiya publications Pvt. Ltd. Mumbai.
4. Cane Sugar Manufacture in India, Kulkarni,D.P., The Sugar Technologists Association of India N.Delhi.
5. Manufacture and Refining of Raw cane sugar; Baikow,V.E., Elesevier publishing Co. AmSterdam London New-york.
6. Unit operations in cane sugar production; Payne, J.N.; Elesevier pub Co. Amsterdam.
7. Machinery and Equipment of the cane sugar factory, Tromp, L.A., Norman Rodger,7&8 Idol Lane.
8. Introduction to cane Sugar Technology, Jenkins, Q.H., Elesevier scientific publishing company Amsterdam.

Program Name	**B.Sc. in Sugar Science & Technology**		Semester	**V**
Course title	**Sugar Processing-IV (Practical)**			
Course Code	**DSC 14-P**		No. of Credits	**02**
Contact hours	**48 Hours (4 Hours/ week)**		Duration of SEA/Exam	**4hours**
Formative Assessment Marks	**10**		Summative Assessment Marks	**40**

Course Pre-requisite(s):

Course Objectives: Students learn about:

1. General subjects adopted for raw sugar analysis.
2. ICUMSA methods for analysis of refined sugar for various parameters.
3. Analysis of plantation white sugar for different parameters.

Course Objectives: Course Specific Outcomes:

After the completion of this course, the student would be able to

1. Understand objectives of sugar analysis.
2. Understand the specifications of different sugars.
3. Handling the equipments like vacuum filtration assembly.
4. Understand the ICUMSA methods adopted different sugars analysis.

List of experiments:-

1. Analysis of raw sugar for
    - Pol %,
    - Moisture%,
    - Conductivity Ash%
    - Dextran,
    - Starch,
    - RS %,
    - ICUMSA color
2. Analysis of refined sugar for
    - color by ICUMSA
    - Pol %,
    - Moisture %,
    - Insoluble matter,
    - Conductivity ash content
    - SO_2 content,
    - RS %,
    - Insoluble matter.
3. Analysis of plantation white sugar for
    - color by ICUMSA
    - Pol %,
    - Moisture %,
    - Insoluble matter,
    - Conductivity ash content
    - SO_2 content, RS %,
    - Insoluble matter

Program Name	**B.Sc. in Sugar Science & Technology**	Semester	**V**
Course title	**WATER AND EFFLUENT TREATMENT (Theory)**		
Course Code	**DSC 15-T**	No. of Credits	**03**
Contact hours	**60 Hours (4 Hours/ week)**	Duration of SEA/Exam	**3hours**
Formative Assessment Marks	**20**	Summative Assessment Marks	**80**

Course Pre-requisite(s):

Course Objectives: Students learn about:

1. Understand global and industrial water management principles and water balance in sugar processing.
2. Study the sources, uses, conservation, and recycling of water in sugar mills.
3. Identify pollution sources, characteristics, and waste streams generated in sugar industries.
4. Learn effluent standards and treatment technologies used for sugar mill wastewater.
5. Understand condensate handling, cooling systems, and advanced filtration methods.
6. Develop knowledge of operation, monitoring, maintenance, and analytical methods used in Effluent Treatment Plants (ETP).

Course Objectives: Course specific outcomes:

After completion of the course, students will be able to:

1. Explain water usage patterns and calculate water balance in sugar factories.
2. Analyze wastewater sources and characteristics from different sections of a sugar mill.
3. Interpret effluent quality parameters such as pH, BOD, COD, TDS, suspended solids, and oil & grease.
4. Compare different biological and physical effluent treatment systems and select suitable methods.
5. Understand condensate recovery, cooling tower operation, and membrane-based purification techniques.

Contents:-

Unit – I **15 Hours**

Water management: Global overview, global water use cycle, computing water uses, Sources of raw water, Use of fresh water in sugar industry, Water balance in sugar processing, Raw water balance in sugar mill, condenser cooling water balance, Waste water generation,

Water conservation program: Resources utilization, Reduce, Reuse and Recycle: Rain water harvesting, water use from sugarcane, measures for reduction of water consumption and waste water generation from all section of sugar mill.

Unit – II **15 Hours**

Pollution sources and characteristics: Solid waste- bagasse, filter cake, boiler ash, ETP Sludge. Liquid waste streams from – Mills, boiling house, boiler, excess condensate, cleaning, spray pond/cooling tower. Characteristics of Waste water from sugar factory

Effluent quality: CPCB Standards for effluent disposal norms – pH, suspended solids, Oil & grease, BOD, COD & TDS.

Effluent treatment: Overview of various effluent treatment systems for sugar mill effluent, Extended Aeration (EA), Activated Sludge Process (ASP), Anaerobic Lagoon (AL) +ASP, Anaerobic Digester +ASP, Bio-tower +ASP, Moving Bed Bio-Reactor (MBBR), Membrane Bio-Reactor (MBR) , Bio-tower + Moving Bed Bio-Reactor (MBBR), Bio-tower + Membrane Bio-Reactor (MBR)

Unit – III **15 Hours**

Condensate water management: Treatment of excess condensate, need of cooling tower, cooling towers, spray pond & cooling water treatment, Condensate policing units and their working, Strainer, membrane filtration, Ultra filtration, Ion exchange reactor, Degasification / Deaeration, pH Adjustment, Final Polishing, Monitoring & Control.

Unit – IV **15 Hours**

Operation and maintenance of ETP: Basic ETP Operations, Maintenance of ETP equipment's, Operational precautions and monitoring, Record keeping, Procedure for culture development, Maintenances of parameters- pH, MLSS, DO, Temp., Chemicals and instruments used in ETP, Wastewater sampling and analysis, Analytical methods & lab equipment's for analysis of treated & untreated effluent.

Tertiary treatment for reuse of waste water- Chlorination, Ozonation, Multi-grade filter, Activated Carbon Filter, UF & RO.

Reference Books:

1. Industrial Wastewater Treatment ; A D Patwardhan
2. Water supply, waste water treatment sewage desposal; Dr. M N Maulik
3. Water treatment technology and management; Mohan Rao K V J
4. Waste Water Treatment; M N Rao, A K Datta
5. Handbook of Waste Water Treatment Plant Operations - 2nd Edition, Frank R Spellman
6. Wastewater Engineering Treatment and Reuse (Part – I), George T, Franklin L. Burton, H. David Stensel

Program Name	**B.Sc. in Sugar Science & Technology**		Semester	**V**
Course title	**Alcohol Technology – II: Distillation & Spent wash Handling (Theory)**			
Course Code	**DSC 16-T**		No. of Credits	**03**
Contact hours	**60 Hours (4 Hours/ week)**		Duration of SEA/Exam	**3hours**
Formative Assessment Marks	**20**		Summative Assessment Marks	**80**

Course Pre-requisite(s):

Course Objectives: Students learn about:

1. Norms for sugar factory effluent discharge as per CPCB / KSPCB board.
2. Different methods/techniques used for effluent treatment.
3. Students will learn Central Pollution Control Board norms for distillery effluent discharge.
4. Different technologies for recycling of water in the distillery. The technology of bio-methanation spent wash to produce biogas.
5. Secondary treatments like evaporation.
6. Concept of incineration of distillery effluent like spent wash. 8. Methods of tertiary effluent treatment (Bio-composting)

Course Specific Outcomes:

After the completion of this course, the student would be able to

1. CPCB / KSPCB board standard norms for sugar factory effluent discharge.
2. Different methods of effluent treatment techniques used in sugar industry.
3. Operation and maintenance of effluent treatment plant.
4. Understand the treatment process of distillery spent wash.
5. Implementation of spent wash treatment in distillery.
6. Technologies available for spent wash bio methanation.
7. Working of different types of evaporators used in distilleries.
8. Different types of incinerations used in distillery.
9. Concept of Bio compost technology.

Contents:-

Unit- 1 **15 Hour**

Basic terms in distillation technology: Definition of distillation, types of distillation, Atmospheric distillation technology process an overview, multi-pressure distillation technology process an overview. Types of alcohol produced in the distillery (R.S., ENA, and anhydrous alcohol), characteristics, Indian std., and uses, Alcohol yields from cane juice, syrup, BH molasses, and C-molasses &various renewable sources. Preparation of anhydrous alcohol by Azeotrophic distillation and molecular sieve dehydration technology.

Unit- 2 **15 Hour**

Ethanol Blended Petrol (EBP) Programme – Challenges, demands, benefits and limitations. Ethanol demand in India & World and future prospectus. Advantages of anhydrous ethanol to blend with petrol. DFPD guidelines for the production of anhydrous

ethanol from cane juice, syrup, BH molasses, and sugar, Denaturation of alcohol, types of denaturants used,By-products of the distillery industry and their formation during the process.

Unit- 3 **15 Hour**

Distillery Effluent (Spent wash)- Definition & Characteristics of distillery effluent (Spent wash), Central Pollution Control Board (CPCB) / Karnataka State Pollution Control Board (KSPCB) norms for disposal of distillery Effluent to achieve "Zero Spent wash Discharge". Spent wash treatment and disposal option to achieve "Zero Spent wash Discharge", **Distillery Effluent treatments:**

Primary Effluent treatment (Bio-methanation of Spent wash to produce biogas)- Introduction- Biogas as an alternative energy source from distillery Spent wash, Types of technologies available for bio-methanation of Spent wash, Salient features of anaerobic digestion of Spent wash, Benefits and limitation of bio-methanation, Steps of reactions involved during degradation of Spent wash by anaerobic method, Composition of biogas and calorific values, Uses of biogas.

Unit- 4 **15 Hour**

Secondary effluent treatment (Spent wash evaporation-MEE)- Classification of evaporators, Different types of evaporators, Incineration of Spent wash- Introduction- Classification and types of incinerators, Advantages and disadvantage of incineration, Design parameters of incinerator boiler, Salient features of incinerator boiler, Analysis of fuel and final ash.

Tertiary effluent treatment (Bio composting)- Introduction- Bio-compost as a fertilizer, Bio compost process, Feedstock requirement for bio compost technology, Salient features of Bio-compost, Benefits and limitation of Bio-compost, Bio-compost monitor parameters, Composition of Bio-compost.

Reference Books:

1. Industrial Alcohol Technology Handbook, NPCS board of consultant & Engineer
2. Handbook of Alcohol Technology by S. V. Patil
3. Sugar Technology for Administrators in the Indian sugar factories; Manohar Rao,P.J.; JayajiraoShinde Editor Bhartiya Sugar JeevanDarshanLaxmi Rd. Pune.
4. System of Technical control for cane sugar factories in India; Varma, N.C. The Sugar Technologists Association of India Delhi.
5. Industrial utilization of sugar cane and its Co-products, Manohar Rao, P.J., ISPCK publishers & Distributors Delhi.

Program Name	**B.Sc. in Sugar Science & Technology**	Semester	**V**
Course title	**Alcohol Technology – II: (Practical)**		
Course Code	**DSC 16-P**	No. of Credits	**02**
Contact hours	**48 Hours (4 Hours/ week)**	Duration of SEA/Exam	**4hours**
Formative Assessment Marks	**10**	Summative Assessment Marks	**40**

Course Pre-requisite(s):

Course Objectives: Students learn about:

1. Understand principles of alcohol analysis and quality evaluation of rectified spirit.
2. Operate analytical instruments such as hydrometers, titration setups, and distillation apparatus.
3. Determine alcohol strength using hydrometric methods.
4. Analyze acidity parameters (total, fixed, and volatile acidity) using standard methods.
5. Quantify impurities such as aldehydes, esters, fusel oils, and furfural in spirit samples.
6. Perform standard quality tests such as potassium permanganate test.
7. Interpret analytical results according to standard specifications.
8. Apply laboratory safety, sampling, and standard analytical protocols.

Course Objectives: Course specific outcomes:

After completion of this practical course, students will be able to:

1. Measure alcohol strength accurately using a hydrometer and standard tables.
2. Perform titrimetric analysis to determine acidity parameters of rectified spirit.
3. Analyze aldehyde and ester content using standard analytical procedures.
4. Identify and quantify fusel oil and furfural impurities in alcohol samples.
5. Conduct quality control tests to assess purity of rectified spirit.

List of Experiments:

1. Determination of strength of alcohol by skies hydrometer.
2. Determination of total & fixed volatile acidity of rectified spirit (ISI method)
3. Determination of volatile acidity of rectified spirit (ISI method)
4. Determination of aldehyde content of Rectified Spirit (AOAC Method)
5. Determination of ester content of Rectified Spirit (AOAC Method)
6. Determination of fusel oil content in spirit sample.
7. Determination of furfural content in spirit sample.
8. To conduct potassium permanganate test for finding the quality of spirit.

Reference books:

1. Industrial Alcohol Technology Handbook, NPCS board of consultant & Engineer
2. Handbook of Alcohol Technology by S. V. Patil
3. Alcohol Technology by Muthag, Vth edition
4. The Alcohol Textbook – Jacques, T. P. Lyons & D. R. Kelsall
5. Alcoholometry – Satyanarayana Rao
6. Handbook of Fermentation and Distillation – A.C. Chatterjee
7. Distillation – H. C. Barron.

Program Name	**B.Sc. in Sugar Science & Technology**	Semester	**V**
Course title	**CHEMISTRY-VA (Theory)**		
Course Code	**DSC-17T**	No. of Credits	**03**
Contact hours	**60 Hours (4Hours/week)**	Duration of SEA/Exam	**3 hours**
Formative Assessment Marks	**20**	Summative Assessment Marks	**80**

Course Pre-requisite(s):

Course Objectives: Students learn about:

1) Chemistry of main group elements.
2) Theory of coordination compounds.
3) Steps involved in metallurgical process.
4) Essential and trace elements in biological process
5) Electrochemical series, Measurement of EMF of chemical cell
6) Importance of polymer and application of phase rule

Course Objectives: Course Specific Outcomes:

After the completion of this course, the student would be able to

1) Understand objectives of coordination compounds.
2) Able to know various process using in metallurgy.
3) Know the biological roles of metals.
4) Understand the concept in electrochemical cell & its applications.
5) To know the importance of polymers and their application in various fields.

Contents

UNIT I **Chemistry of main group elements-** Structure and bonding in boranes, carboranes, metallocarboranes, Wades rules, borazines, phosphazenes, S,N- compounds.Silicates- Classification, structures, isomorphous replacement, pyroxenes, layered and vitreous silicates, zeolites and molecular sieves. **Review of terms:** double salts, complex salts, central metal ion, ligand, types of ligands, complex ion and coordination number. IUPAC nomenclature Valence bond theory of coordination compounds with reference to $(Fe(CN)_6]^{-3}$, $(Fe(CN)_6]^{-4}$,$[FeF_6]^{-3}$, $[Zn(NH_3)_4]^{+2}$, $[Ni(CN)_4]^{-2}$ and its limitations. Isomerism–Ionisation, hydrate, linkage, geometrical and optical in coordination Compounds with respect to coordination number 4 and 6.	**15 Hours**
UNIT II **Metallurgy** Minerals, ores, stages in metallurgy (crushing, concentration, calcination, roasting, smelting/reduction, refining). Characteristics, uses and limitations of Ellingham diagrams for reduction of metal oxides using carbon as reducing agent.	**15 Hours**

Extraction of nickel by Mond's process, Lead by carbon reduction process, aluminum from bauxite. Powder metallurgy – Production of tungsten powder from wolframite. **Bioinorganic Chemistry** Essential and trace elements in biological process, metalloporphyrins with respect to haemoglobin and chlorophyll (structure and function), biological role of Na, K, Fe and Zn.	
UNIT III **Electrochemistry- II** Electrochemical series, Measurement of EMF of chemical cell by potentiometer, reversible and irreversible cells, Weston standard cell, Types of electrodes –Reference electrodes, Standard Hydrogen Electrode (SHE), Calomel Electrode, Silver chloride electrode, Sign convention. Nernst Equation, concept of equilibrium in electrochemical cell, concentration cell, cell with liquid junction, expression for EMF of an electrolyte concentration cell with transference & without transference, significance of salt bridge. Applications of emf measurements –(a) Determination of pH: Using hydrogen electrode, quinhydrone electrode and glass electrode, (b) Potentiometric titrations: Acid-base and redox titration.	**15 Hours**
UNIT IV **Polymers**: Introduction, definition, classification, degree of polymerization. Mechanism of polymerization- Free radical, ionic and Zeigler – Natta polymerization. Molecular weight of polymers- Number average molecular weight and mass average molecular weight, Determination of molecular weight by Viscometry and Osmotic pressure method, Synthesis of some polymers Nylon 6,6, PVC, Bakelite, Polypropylene and its applications. **Phase rule** Terminology and explanation of the terms involved. Applications of phase rule-One component system-water and sulphur systems Two-component systems-Bismuth-Cadmium system and KI – water system. Eutectic and freezing mixture.	**15 Hours**

Reference Books:

1. Basic Inorganic Chemistry- F. A. Cotton, G. Wilkinson and P. L. Gaus; John Wiley and sons. Inc, 6th edition (1999).
2. Advanced InorganicChemistry,6th edition; F.A.Cotton and G.Wilkinson.
3. Inorganic Chemistry IV edition;J.E.Huheey,E.A.Keiter and R.L.Keiter, Addison;Wesley (1993).
4. Inorganic Chemistry, II edition, D.F.Shriver, P.W.Atkins and C.H. Langford, ELBS; Oxford University Press, 1994.
5. Physical Chemistry, P.W.Atkins, Julio de Paula, ELBS,7thedition,(2002).
6. Physical Chemistry: A Molecular Approach, Mc Quarie and Simon,Viva, NewDelhi,(2001).
7. Introduction to Quantum Chemistry, A.K.Chandra,TataMc Graw Hill,(1988).
8. S.H. Maran and C. F. Pruton, 4th Edn., Oxford, & IBH publishing Co. Pvt. Ltd. New Delhi(1965).
9. Physical Chemistry-P.AtkinsandJ.D.Paula,9 th Edn.,Oxford University Press(2010).
10. Biochemistry,-Geoffrey Zubay, 2nd Edn., Macmillan Publishing Co.New York(1981).
11. Text Book of Physical Chemistry - P. L. Soni, S. Chand & Co., 1993.
12. A text book of Physical Chemistry- A. S. Negi & S C Anand, 3rd edition 2022.\

Program Name	**B.Sc. in Sugar Science& Technology**	Semester	**V**
Course title	**CHEMISTRY-VB (Theory)**		
Course Code	**DSC-18T**	No. of Credits	**03**
Contact hours	**60 Hours (4Hours/week)**	Duration of SEA/Exam	**3 hours**
Formative Assessment Marks	**20**	Summative Assessment Marks	**80**

Course Pre-requisite(s):

Course Objectives: Students learn about:

1. Various Heterocyclic compounds, Synthesis & reactivity.
2. Biological role and deficiency diseases of Vitamins
3. Classification of carbohydrates & their structures
4. Types of electronic transitions, calculation of λ_{max}
5. Principle of Nuclear magnetic resonance spectroscopy

Course Objectives: Course Specific Outcomes:

After the completion of this course, the student would be able to

1. Understand objectives of Heterocyclic compounds.
2. Able to know various deficiency diseases of Vitamins
3. Understand the techniques of Electronic spectroscopy.
4. Understand the NMR spectroscopy and its applications.

Contents

UNIT-I **Heterocyclic compounds** Nomenclature of heterocyclic compounds. Structure, reactivity, synthesis and reactions of furun, thiophene, pyrrole, pyridine, indole, quinoline and isoquinoline. **Vitamins** Biological role and deficiency diseases of Vitamins A, Vitamin B1 (thiamine), Vitamin B6 (pyridoxine), folic acid, pantothenic acid, riboflavin, Vitamin C, Vitamin E (tocopherol), Vitamin H (biotin), Vitamins K1 and K2, Synthesis of Vitamin A & Vitamin C.	**15 Hours**
UNIT-II **Carbohydrates** Introduction, definition and classification, D and L structure of glucose, Haworth and Fischer structure of Glucose, Fructose, Stereoisomers of (+)-glucose, Oxidation of Glucose by Nitric Acid, Osazone formation of (+)-Glucose and (-)-Fructose, Killiani's synthesis, Ruff'sdegradation.Epimers&epimerisationConversionofaldoseintoKetose&Ketoseto aldose, Formation of glycosides, Configuration about C-1 (anomers), Methylation, Mutarotation, Structures of ribose & deoxyribose. An introduction to disaccharides (maltose, sucrose & lactose) & polysaccharides (Startch& Cellulose), Reducing and Non-reducing sugars. Biological importance of carbohydrates.	**15 Hours**
Unit-III **Organic Spectroscopy** General principles Introduction to absorption and emission spectroscopy. **Electronic Spectroscopy** Concept potential energy curves for bonding and anti bonding molecular orbitals, qualitative description of selection rules, energy levels and respective qualitative	**15 Hours**

transitions, Frank-condon principle. Types of electronic transitions, λ_{max}, Chromophores and Auxochromes, Bathochromic and Hypsochromic shifts, Intensity of absorption; Application of Woodward Rules for calculation of λ_{max} for the following systems: a,ß unsaturated aldehydes, ketones, carboxylic acids; Conjugated dienes: alicyclic, homoannular and heteroannular; Extended conjugated systems (aldehydes, ketones and dienes); distinction between cis and trans isomers.	
Unit-IV **Nuclear Magnetic Resonance spectroscopy** Principle of Nuclear magnetic resonance spectroscopy: Magnetic properties of nuclei, population of energy levels, the Larmor precession, relaxation processes, chemical shift, shielding mechanism ,spin-spin interactions, rules governing the interpretation of first order spectra, effect of chemical exchange on spectra. chemical shift, nuclear shielding and deshielding, spin-spin coupling (n+1) rule, intensity (height) of the signal, TMS as internal standard-advantages, Analysis of NMR spectra of simple organic molecules such as ethyl bromide, n-propyl bromide, iso propyl bromide, ethanol, acetaldehyde and benzene.	**15 Hours**

Reference Books:

1. Advanced Organic Chemistry - Reactions, Mechanism and Structure, Jerry March, John Wiley (2008).
2. Advanced Organic Chemistry, F A Carey and R J Sundberg Plenum,(1990).
3. A Guide Book to Mechanism in Organic Chemistry, Peter Sykes, Longman,(2000).
4. Structure and mechanism of Organic Chemistry, C K Ingold, Cornell University Press(1999).
5. Organic Chemistry, RT Morrison and RN Boyd, Prentice-Hall,(1998).
6. Modern Organic Reactions, HO House, Benjamin,(1972).
7. Principles of Organic Synthesis, ROC Norman and JMCoxon, Blackie Academic and Professional,(1996).
8. Organic Chemistry, Volumes I and II, I L Finar, Longman,(1999).
9. Laideler K.J.and MeiserJ.M. Physical Chemistry Third Edition(International)1999
10. LevineI. N., Physical Chemistry, Fourth Edition),McGraw-Hill(International),1995.
11. McQuarrieD.A.andSimonJ.D.PhysicalChemistry-AMolecularApproach,University Science Books, 1998.
12. P.W.Atkins: Physical Chemistry.
13. G.W.Castellan: Physical Chemistry.
14. Banwell,C.N. & Mc Cash, E.M. Fundamentals of Molecular Spectroscopy 4th Ed.TataMcGraw-Hill:New Delhi (2006).
15. Brian Smith: Infrared Spectral Interpretations: A Systematic Approach.
16. Kemp, W. Organic Spectroscopy, Palgrave
17. Principles of Instrumental Analysis - 6th Edition by Douglas A. Skoog, F. James Holler, and Stanley Crouch (ISBN 0-495-01201-7).
18. Instrumental Methods of Analysis,7 th ed, Willard, Merritt, Dean, Settle.

Program Name	**B.Sc. in Sugar Science & Technology**	Semester	**V**
Course title	**CHEMISTRY-V(Practical)**		
Course Code	**DSC-18P**	No. of Credits	**02**
Contact hours	**48 Hours (4Hours/week)**	Duration of SEA/Exam	**4 hours**
Formative Assessment Marks	**10**	Summative Assessment Marks	**40**

Course Pre-requisite(s):

Course Objectives: Students learn about:

1. General techniques adopted for quantitative analysis of inorganic complexes.
2. Colorimetric methods for analysis of ions present in solution.
3. Conductometric analysis of acid mixture.

Course Objectives: Course Specific Outcomes:

After the completion of this course, the student would be able to

1. Understand objectives of inorganic complex synthesis.
2. Understand the colorimetric estimation of ions.
3. Handling the equipment's like conductometer, colorimeter, pH meter.
4. Understand the verification of Beer-Lamberts Law

Contents

Section A: Inorganic Chemistry:

Preparation and quantitative analysis of inorganic complexes:

1. Bis(dimethylglyoximato) nickel (II)
2. Preparation of trans-potassium diaqua bis (oxalato) chromate (III)
3. Tris (thiourea) copper (I) sulphate
4. Sodium tris (oxalate) ferrate (III)

Section B: Physical Chemistry

1. Verification of Beer-Lamberts Law by colorimetric method and calculation of molar extension coefficient for Cu^{2+} ions.
2. Verification of Beer-Lamberts Law by colorimetric method and calculation of molar extension coefficient for Fe^{2+}ions.
3. Conductometric titration of weak acid vs. weak base (CH_3COOH vs NH_4OH).
4. Determination of pH of acetic acid with sodium acetate buffer by pH metry method.

Section C: Organic Preparations

1. Preparation of Phthalimide from Phthalic anhydride
2. Preparation of p-Nitro acetanilide from Acetanilide
3. Preparation of 1,1'-bis-2-napthol from 2-naphthol
4. Preparation of Acetanilide from Aniline

References:

1. Experiments in Physical Chemistry by Shoemaker and Garland, Mc Graw Hill International Edn. (1966)
2. Advanced Practical Physical Chemistry by J.B.Yadav, Goel Publications Meerut(1988)
3. Senior Practical Physical Chemistry by B.C. Kosla, Simla Printers New Delhi(1987)
4. Experimental Physical Chemistry by Daniel et al., Mc Graw Hill, NewYork(1962).
5. Practical Physical Chemistry by A.M James and P.E. Pritchard, Longman's Group Ltd(1968)
6. Experimental Physical Chemistry by Wilson, Newcombe & others, Pergamon Press, New York (1962)
7. Experimental Physical Chemistry by R.C. Behraand B Behra, Tata McGraw, New Delhi (1983)
8. Experimental Physical Chemistry by V.D. Atavale and Parul Mathur, New Age International, New York (2001)
9. Physical Chemistry Laboratory Principles and Experiments by H.W.Salberg J.I.Morrow, S. R.Cohenand M.E.
10. Vogel's text book of Quantitative Chemical Analysis,5th Edition, J. Bassett, G.H.Jeffery and J. Mendham, and R.C. Denny, Longman Scientific and Technical (1999).
11. Inorganic Semi micro Qualitative Analysis,V.V. Ramanujam;The National Pub. Co.(1974).
12. Practical Inorganic Chemistry, G. Marrand B.W. Rockett, Von Nostrand Reinhold Co., London (1972).

Program Name	**B.Sc. in Sugar Science & Technology**	Semester	**V**
Course title	Compulsory-2 Practical Knowledge Skill: Industrial Visit Report		
Course Code		No. of Credits	**02**
Contact hours	**24 Hours (2 Hours/ week)**	Duration of SEA/Exam	
Formative Assessment Marks	**10**	Summative Assessment Marks	**40**

Course Pre-requisite(s):

Course Objectives: Students learn about:

1. Understand real industrial working environments and professional practices.
2. Correlate theoretical knowledge with actual industrial processes.
3. Observe industrial operations, machinery, and process flow systems.
4. Study safety practices, quality control, and environmental management in industries.
5. Learn organizational structure, workflow, and production management.
6. Interact with industry professionals and understand career opportunities.
7. Develop technical observation, documentation, and reporting skills.

Course Objectives: Course specific outcomes:

After completion of this practical course, students will be able to:

1. Describe industrial processes and operations observed during the visit.
2. Relate classroom concepts to real-life industrial applications.
3. Explain plant layout, equipment functions, and workflow systems.
4. Identify safety measures and quality control practices followed in industries.
5. Prepare a structured technical report based on observations.
6. Demonstrate professional communication and observational skills.

Unit-1

Pre-Visit Preparation

Introduction to industry type and background, Study of plant process flow diagram, Safety instructions and visit guidelines, Questionnaire preparation for industry interaction.

Industrial Visit Observation

Students must observe and record: Plant layout and department functions, Raw materials and utilities used, Manufacturing process stages, Equipment and machinery working principles, Quality control laboratory practices, Waste management and pollution control systems, Safety and maintenance practices, Organizational hierarchy and management system.

Unit-2

Data Collection & Interaction

Interaction with technical staff and engineers, Recording technical specifications, Collection of brochures, manuals, and data sheets, Discussion on production capacity and efficiency, Industrial challenges and innovations

Report Preparation & Presentation

Structure of industrial visit report: Introduction of industry, Process description, Equipment details, Observations, Learning outcomes, Conclusion, Technical report writing format, Oral presentation / viva voce.

Reference Books:

1. Hand book of Cane Sugar Engineering, Hugot e., Elesevier Science publishing Co.Inc. New York.
2. Sugar Technology for Administrators in the Indian sugar factories; ManoharRao,P.J.; JayajiraoShinde Editor Bharatiya Sugar Jeevan DarshanLaxmi Rd. Pune.
3. Training manual for sugar mills. Mangal Singh; Somaiya publications Pvt.Ltd. Mumbai.

Semester-VI

Program Name	**B.Sc. in Sugar Science & Technology**		Semester	**VI**
Course title	**INDUSTRIAL MANAGEMENT (Theory)**			
Course Code	**DSC 19-T**	No. of Credits		**03**
Contact hours	**60 Hours (4 Hours/ week)**	Duration of SEA/Exam		**3hours**
Formative Assessment Marks	**20**	Summative Assessment Marks		**80**

Course Pre-requisite(s):

Course Objectives: Students learn about:

1. Understand different forms of business organizations and their legal, financial, and functional characteristics.
2. Study administrative and management structures used in industrial organizations, especially sugar factories.
3. Gain knowledge of statutory approvals, legal requirements, and industrial laws governing factory operations.
4. Understand principles of Human Resource Management including recruitment, training, welfare, discipline, and safety.
5. Learn materials management systems such as purchasing, inventory control, spare parts management, and ERP concepts.

Course Objectives: Course specific outcomes

After successful completion of this course, students will be able to:

1. Compare different forms of business organizations and select suitable structures for industrial setups.
2. Explain management hierarchy, delegation, and administrative functions in factories.
3. Interpret major industrial laws applicable to manufacturing industries.
4. Apply HRM principles for manpower planning, motivation, discipline, and welfare.
5. Implement basic materials management and inventory control techniques.

Contents:-

Unit-I **15 Hours**

Forms of Business Organization: Introduction, duties and responsibilities of organisation, types of business organisation (private companies, partnership organization, joint stock companies, private and public limited company applications, advantages, disadvantages. Raising finance for joint stock company, cooperative societies. State ownership - Government Departmental organisations public corporations liabilities, distinctions, limitations between various forms of organisations. Criteria for setting up of sugar factory, statutory approvals, laws governing sugar industry.

Administrative & Management Structure: Definition of administration, duties and responsibilities of management, Chain of command, delegation of authority & responsibility, line - staff organisation, financial organisation, management structure in sugar industry.

Unit-II **15 Hours**

Human Resource Management: Introduction to HRM, duties of HR Manager, Staff recruitment procedure, training, discipline, motivation, safety, industrial psychology, welfare, personnel administration with reference to sugar factory (time keeping, labour turnover, absenteeism). Social Responsibility of Organisation - CSR initiatives. Industrial Acts: Introduction and brief Description various industrial acts (Indian Factories Act - 1948, Indian Electricity Act - 1910, Indian Electricity Rule - 1956, Indian Boiler Act - 1923, Industrial Disputes Act, Workmen's Compensation Act 1923, Employee's State Insurance Act - 1948, Payment of Wages Act - 1936, Trade Union Act - 1926)

Unit-III **15 Hours**

Materials Management: Methods of purchasing (raw material, machineries & spares), stores & store keeping, system of location of materials, procedure for issue & return, spare parts management, inventory control, Management information systems & ERP.

Finance Management: Elements of cost calculation of different costs with examples (Material, Labour, Fixed, Variable), depreciation, methods of calculating depreciations - interest on capital, idleness, maintenance- equipment replacement policy, loss & profit, budgetary control.

Unit-IV **15 Hours**

Production Management: Definition of Productivity, factors affecting productivity, measures to improve productivity, factory lighting.

Quality Management Systems & SHE (Safety, Health & Environment): Introduction to Quality Management Systems (OMS) - ISO 9001, Food Safety Management Systems (FSMS) - ISO 22000, Hazard Analysis and Critical Control Point (HACCP), Good Hygienic Practices (GHP), Good Manufacturing Practices (GMP), Environmental Management Systems - ISO 14001 and Laboratory Management Systems - ISO 17025.

Reference Books

1. “Cane Sugar Handbook" by James C. P. Chen & Chung Chi Chou
2. “Operations Management" by Jay Heizer and Barry Render / Krajewski & Ritzman
3. “Total Quality Management" by Dale H. Besterfield
4. “Management Accounting" by Khan & Jain

5. “Human Resource Management" by Gary Dessler

6. “Industrial Relations and Labour Laws" by Sinha, Sinha, &Shekhar

7. “Sugar Industry and Environmental Pollution“by Dr. B.K. Sharma

8. “Management in Sugar Industry“(Special Compilation / University Text) published by Indian Institute of Sugarcane Research (IISR), Lucknow

Program Name	**B.Sc. in Sugar Science & Technology**		Semester	**VI**
Course title	**ALLIED SUGAR MANUFACTURING (Theory)**			
Course Code	**DSC 20-T**		No. of Credits	**03**
Contact hours	**60 Hours (4 Hours/ week)**		Duration of SEA/Exam	**3hours**
Formative Assessment Marks	**20**		Summative Assessment Marks	**80**

Course Pre-requisite(s):

Course Objectives: Students learn about:

1. Understand the manufacturing processes of traditional and modern sugar products such as khandsari, jaggary, candy sugar, raw sugar, and refined sugar.
2. Study process flow diagrams and unit operations involved in sugar processing.
3. Learn extraction and clarification techniques for cane juice.
4. Understand boiling, crystallization, centrifugation, drying, grading, and packing operations.
5. Study specifications and quality standards for different sugar products including export standards.
6. Learn modern technologies such as pressure pan systems, carbonation, phosphotation, and ion-exchange de-colorization.

Course Objectives: Course specific outcomes

After completion of the course, students will be able to:

1. Explain manufacturing processes of khandsari, jaggery, candy sugar, raw sugar, and refined sugar.
2. Draw and interpret process flow diagrams for sugar processing systems.
3. Select suitable clarification and crystallization techniques based on product type.
4. Evaluate quality parameters and standards of different sugar products.
5. Compare traditional and modern sugar manufacturing technologies.
6. Analyze factors affecting sugar quality, recovery, and storage stability.
7. Describe refinery operations including affination, melt clarification, filtration, and crystallization.

Contents:-

Unit – I **15 Hours**

Manufacturing of Khandsari Sugar: Specification of Khandsari sugar, Process flow chart, Extraction & clarification of cane juice, Open pan boiling system, Modern pressure effect khandsaries, Application of modern methods for crystallization, Centrifuging; drying & packing.

Unit – II **15 Hours**

Manufacturing of Jaggary (Gur): Composition of jaggary, Process flow chart, Extraction of cane juice, Clarification of juice, Concentration of juice, Drying & grading of jaggary, Storage of jaggary, forms of jaggary, Factors affecting the quality of jaggary, BIS standards for jaggary.

Manufacturing of Candy Sugar: Melt clarification, Crystallization technique of candy sugar, Centrifuging, drying & packing

Unit – III **15 Hours**

Manufacturing of Raw Sugar: Raw Sugar, Specification for raw sugar, Export quality standards for raw sugar, VHP, VVHP raw sugar specifications, Process flow chart, clarification method:- Defecation process, types of defecation, massecuite boiling scheme, process overview and Raw value.

Unit – IV **15 Hours**

Manufacturing of Refined Sugar: Specification of refined sugar, Types of refineries:- back end and Standalone refinery, Raw sugar quality requirement, Raw Sugar melter/Mingling & affination, Clarification of raw sugar melt by carbonation, Clarification of raw sugar melt by phosflotation, Scum de-sweetning alternatives, use of Ion Exchange resins for melt decolourisation, Multi bed filter (MBF), Deep bed filter (DBF), Back end refinery operation- Evaporation scheme, Sugar refining scheme, normal massecuite % cane, steam, power & water requirement

Standalone refinery operation: Sugar refining scheme, normal massecuite % cane, steam, power & water requirement, Chemicals used for sugar refining and their quality control.

Reference Books:

1. Principles of sugar technology, Honig Pieter, Elesevier publishing company Amsterdam
2. Hand book of Cane Sugar Engineering, Hugot e., Elesevier Science publishing Co.Inc. New York.
3. Cane Sugar Manufacture in India, Kulkarni, D.P., The Sugar Technologists Association of India N.Delhi.
4. System of Technical control for cane sugar factories in India; Varma, N.C. The Sugar Technologists Association of India N.Delhi.
5. Manufacture and Refining of Raw cane sugar; Baikow, V.E., Elesevier publishing Co. Am Sterdam London New-york.
6. Sugar Science and Technology, Birch, G.G. Parker, K.J. Applied science publishers Ltd. London.
7. Technology for sugar Refinery Workers, Oliver Lyle, Chapman & Hall Ltd. London.
8. Handbook of Sugar Refining, Chung Chi Chou, John Wiley & Sons Inc, New York

Program Name	**B.Sc. in Sugar Science & Technology**		Semester	**VI**
Course title	**ALLIED SUGAR MANUFACTURING (Practical)**			
Course Code	**DSC 20-P**		No. of Credits	**02**
Contact hours	**48 Hours (4 Hours/ week)**		Duration of SEA/Exam	**4 hours**
Formative Assessment Marks	**10**		Summative Assessment Marks	**40**

Course Pre-requisite(s):

Course Objectives: Students learn about:

1. Understand the principles of quality analysis of jaggery, raw sugar, and refined sugar.
2. Perform quantitative analysis of sucrose, moisture, reducing sugars, and insoluble matter in jaggery.
3. Determine key quality parameters of raw sugar such as Pol %, moisture, conductivity ash, dextran, starch, reducing sugars, and ICUMSA color.
4. Analyze refined sugar for purity and quality indicators including ICUMSA color, Pol %, moisture, ash, insoluble matter, and SO_2 content.
5. Operate laboratory instruments used in sugar analysis such as polarimeters, spectrophotometers, and moisture analyzers.

Course Objectives: Course specific outcomes

After completion of the course, students will be able to:

1. Explain manufacturing processes of khandsari, jaggery, candy sugar, raw sugar, and refined sugar.
2. Draw and interpret process flow diagrams for sugar processing systems.
3. Select suitable clarification and crystallization techniques based on product type.
4. Evaluate quality parameters and standards of different sugar products.
5. Compare traditional and modern sugar manufacturing technologies.

List of Experiments:-

1. Analysis of Jaggary for
    - Sucrose%,
    - Moisture %,
    - Reducing Sugars %,
    - Water Insoluble matter %,
2. Analysis of raw sugar for
    - Pol %,
    - Moisture %,
    - Conductivity Ash %
    - Dextran,
    - Starch,
    - RS %,
    - ICUMSA color.

3. Analysis of refined sugar for
    - ICUMSA color.
    - Pol %,
    - Moisture %,
    - Insoluble matter,
    - Conductivity ash content
    - SO_2 content,
    - RS %,
    - Insoluble matter.

Program Name	**B.Sc. in Sugar Science & Technology**	Semester	**VI**
Course title	**Sugar Engineering-III: BASICS OF CHEMICAL ENGINEERING (Theory)**		
Course Code	**DSC 21-T**	No. of Credits	**03**
Contact hours	**60 Hours (4 Hours/ week)**	Duration of SEA/Exam	**3hours**
Formative Assessment Marks	**20**	Summative Assessment Marks	**80**

Course Pre-requisite(s):

Course Objectives: Students learn about:

1. Understand the definition, scope, and industrial relevance of chemical engineering and process industries.
2. Apply units, dimensions, and process variables in engineering calculations.
3. Perform stoichiometric calculations for industrial reactions including combustion of fuels such as bagasse and sulphur.
4. Understand fluid properties, fluid flow principles, and working of pumps used in industries.
5. Study modes of heat transfer and analyze heat exchangers, boiling phenomena, and insulation efficiency.

Course Objectives: Course specific outcomes

After completion of the course, students will be able to:

1. Explain basic chemical engineering concepts, process variables, and unit operations.
2. Solve stoichiometric problems related to industrial chemical reactions and combustion processes.
3. Analyze fluid flow systems and select suitable pumps for industrial applications.
4. Evaluate heat transfer mechanisms and calculate heat flux and thermal efficiency.
5. Interpret mass transfer phenomena and their applications in evaporation, crystallization, drying, and cooling.
6. Describe working principles of separation and mechanical unit operations.

Contents:-

Unit-I **15 hours**

Definition and Scope of Chemical Engineering, Chemical Process Industries, Units and Dimensions, Basic Concepts of Process Variables, Elementary chemical engineering concepts, concept of unit operations.

Stoichiometry: Introduction, applications in industrial problems, chemistry of combustion reactions, combustion of sulphur & Bagasse, Stoichiometric calculation.

Fluid mechanics: Types of fluids, Fluid statics, fluid dynamics, flow measurement, types of fluid flow, transportation of fluids, pumps, positive displacement and centrifugal pumps, types of pumps used in sugar industry.

Unit-II **15 hours**

Heat transfer: Heat transfer, Modes of heat transfer:- Conduction, Convection & Radiation, thermal resistance and heat flux, Types of heat exchangers, Nucleate boiling curves, calculation of boiling heat flux, Vapour compression, Heat efficiency, Heat transfer through flat and curved surfaces and effects of insulation and its efficiency, Factors affecting on heat transfer.

Unit-III **15 hours**

Mass transfer: Fundamentals of mass transfer:- definition, importance of mass transfer in chemical process, driving force for mass transfer, industrial applications, Diffusion mechanism: Molecular diffusion & eddy diffusion, mass transfer in gases & liquids system, Evaporation: principle, types, factors affecting, Applications in sugar and chemical industry, crystallization: Principle and supersaturation concept, factors affecting and industrial applications, Drying: Objectives, Types of dryers and factors affecting, & cooling: Principle, cooling towers and industrial exaples.

Unit-IV **15 hours**

Unit operations: Size reduction: objectives & equipments used for size reduction. **Screening**: purpose and types of screens used, **Leaching and extraction**: Principles of solid-liquid extraction, mechanism, types, factors affecting on leaching. **Mixing and Agitation**: objectives, types of mixing, flow patterns. **Gas absorption**: principles and mechanism of gas absorption, **Sedimentation**: Stoke's law and types of settling. **Filtration**: Theory of filtration, types and applications. **Centrifugation**: Principle, c/f force, types of centrifuge and miscellaneous separation operations.

REFERENCE BOOKS:

1. Introduction to Chemical Engineering, Walter L. Badger, Julius T. Banchero, 29th edition.
2. Introduction to Chemical Engineering, Walter L Badger.
3. Unit Operation of Chemical Engineering, Warren L McCabe, Julian C. Smith, Peter Harriott, 7th edition, 2015
4. Fluid flow Opetation - A laboratory Manual in Chemical Engineering, M S Vishwanathan
5. Chemical Engineering: Design, Ray Sinnott, Gavin Towler, 5th edition
6. Introduction to Chemical Engineering, Walter L Badger Julius T Banchero, 2018.

Program Name	**B.Sc. in Sugar Science & Technology**		Semester	**VI**
Course title	**SUGAR INDUSTRY CO-PRODUCTS (Theory)**			
Course Code	**DSC 22-T**		No. of Credits	**03**
Contact hours	**60 Hours (4 Hours/ week)**		Duration of SEA/Exam	**3hours**
Formative Assessment Marks	**20**		Summative Assessment Marks	**80**

Course Pre-requisite(s):

Course Objectives: Students learn about:

1. Understand the properties, composition, and quantities of major sugar industry by-products such as bagasse, press mud, and molasses.
2. Study quality parameters and storage methods for bagasse, press mud, and molasses.
3. Learn industrial applications of bagasse including fuel, paper, boards, ethanol production, and gasification.
4. Understand the composition, handling, and uses of press mud including fertilizer, wax extraction, biogas, and feed applications.
5. Study the characteristics of final molasses and its role as a fermentation raw material.
6. Compare molasses and cane juice as substrates for fermentation industries.

Course Objectives: Course specific outcomes

After completion of the course, students will be able to:

1. Identify major by-products and co-products generated in sugar factories.
2. Describe composition, properties, and quality standards of bagasse, press mud, and molasses.
3. Evaluate storage requirements and handling practices for different by-products.
4. Compare industrial applications and economic value of various sugar industry residues.
5. Assess suitability of molasses and juice for fermentation processes.
6. Explain processes such as bagasse gasification and wax recovery from press mud.
7. Analyze utilization methods for waste materials such as spent wash, boiler ash, and cane trash.

Contents:-

Unit-I **15 Hours**

Bagasse: Definition, normal quantities, composition of Bagasse, General quality standards for Bagasse Pol % / Brix % / Moisture % / pith / fiber /GCV/NCV, Storage of Bagasse, General use of Bagasse - Fuel for boiler and related power production / paper production/ ethanol production/cattle feed /particle board / fibre board, Separation of pith from bagasse, General process of bagasse gasification technology, other use of bagasse and bagasse ash.

Unit-II **15 Hours**

Press Mud / Filter cake: Definition, normal quantities, composition of press mud, General quality standards for press mud - Pol% / moisture %, Storage of press Mud, general use of Press Mud - Bio-Fertiliser / fuel /cattle feed / cane wax/bio gas production.

Unit-III **15 Hours**

Final Molasses: Definition, normal quantities, composition of final molasses, storage of final molasses, General use of final molasses for fermentation, Use of cane juice for fermentation, Comparison of Final Molasses & juice as basic raw material for fermentation industry.

Unit-IV **15 Hours**

Other co-products: Cane trash:- Use of cane trash as organic manure / boiler fuel, Boiler ash:- Use of boiler ash as manure, Carbon dioxide gas from fermentation:- Beverage carbonation, dry ice, Spent wash: Concentrated spent wash as manure, boiler fuel, CBG production.

Reference Books:

1. Sugar Technology for Administrators in the Indian sugar factories; Manohar Rao, P.J.; Jayajirao Shinde Editor Bharatiya Sugar Jeevan Darshan Laxmi Rd. Pune.

2. Training manual for sugar mills.; Mangal Singh; Somaiya publications Pvt.Ltd. Mumbai.

3. System of Technical control for cane sugar factories in India; Varma, N.C. The Sugar Technologists Association of India N.Delhi.

4. Sugar Science and Technology, Birch, G.G. Parker, K.J. Applied science publishers Ltd. London.

5. The principles of cane sugar manufacture, Davies, J.G., Norman Rodger; London

6. Industrial utilization of sugar cane and its Co-products, Manoharrao, P.J., ISPCK publishers & Distributors New Delhi.

Program Name	**B.Sc. in Sugar Science & Technology**	Semester	**VI**
Course title	**SUGAR INDUSTRY CO-PRODUCTS (Practical)**		
Course Code	**DSC 22-P**	No. of Credits	**02**
Contact hours	**48 Hours (4 Hours/ week)**	Duration of SEA/Exam	**4hours**
Formative Assessment Marks	**10**	Summative Assessment Marks	**40**

Course Pre-requisite(s):

Course Objectives: Students learn about:

1. Understand analytical principles used for testing sugar industry by-products.
2. Determine moisture and sucrose (Pol %) content of bagasse and filter cake.
3. Measure calorific values (GCV and NCV) of bagasse for fuel evaluation.
4. Analyze boiler ash composition for industrial or agricultural use.
5. Perform quality analysis of compost derived from sugar industry wastes.
6. Determine molasses quality parameters such as Brix %, Pol %, and purity.

Course Objectives: Course specific outcomes

After completion of the course, students will be able to:

1. Perform laboratory analysis of bagasse, molasses, filter cake, ash, and compost samples.
2. Measure key quality parameters such as moisture, Pol %, Brix %, purity, and sugar fractions accurately.
3. Determine fuel characteristics of bagasse using calorific value calculations.
4. Evaluate industrial usability of by-products based on analytical results.
5. Conduct chemical analyses for reducing sugars, acidity, and fermentability of molasses.

List of Experiments:-

1. Analysis of Bagasse for pol% and moisture %.
2. Analysis of Bagasse for GCV and NCV.
3. Analysis of boiler ash.
4. Analysis of Filter cake for pol% and moisture %.
5. Analysis of compost.
6. Analysis of molasses for Brix%, Pol % and purity.
7. Analysis of molasses for RS%, TRS% and Volatile acidity.
8. Analysis of molasses for UFS and FS.

Program Name	**B.Sc. in Sugar Science& Technology**	Semester	**VI**
Course title	**CHEMISTRY-VIA(Theory)**		
Course Code	**DSC-23T**	No. of Credits	**03**
Contact hours	**60 Hours (4Hours/week)**	Duration of SEA/Exam	**3 hours**
Formative Assessment Marks	**20**	Summative Assessment Marks	**80**

Course Pre-requisite(s):

Course Objectives :Students learn about:

1. Metal-Ligand equilibria in solution & Metal-ligand bonding
2. Classifications of acids and bases as hard & softs
3. Vibrational Spectroscopy, IR absorptions of compounds containing various functional groups,
4. Quantum Chemistry & Photochemistry

Course Objectives: Course Specific Outcomes:

After the completion of this course, the student would be able to

1. Understand objectives of Metal-ligand bonding.
2. To known various dyes and their applications
3. Able to know various IR absorption positions using in Vibrational Spectroscopy
4. Know the Classifications of acids and bases.
5. Understand the techniques of Quantum Chemistry & Photochemistry.

Contents

UNIT-I **Metal-Ligand equilibria in solution** Step-wise and overall formation constant and their relationship, trends in step-wise constant,kineticandthermodynamicstabilityofmetalcomplexes,factorsaffectingthe stability of metal complexes with reference to the nature of the metal ion and ligand, chelate effect, macrocyclic effect and their thermodynamic origin. **Metal-ligand bonding** Stereoisomerism- coordination numbers 3 to 8. Crystal field theory, salient features, spectrochemical series, splitting of d-orbitals in tetragonal, square planar, trigonal bipyramidal and square-pyramidal geometry, applications of CFT-colours of transition metal complexes, magnetic properties of octahedral complex, distortion of octahedral complex, CFSE and their uses, factors affecting CFSE, limitations of CFT	**15 Hours**
UNIT-II **Acid-Bases and Dyes** Classifications of acids and bases as hard & soft, Person's HSAB concept, acid base strength and hardness & softness. Symbiosis, theoretical basis of hardness & softness, electronegativity - hardness & softness. **Acid-Base theories** Arrhenius, Bronsted-Lowry, The Lux - Flood, solvent system and Lewis concept of acids & bases. **Dyes** Colour and constitution, synthesis and applications of congo red, malachite green, phenolphthalein and alizarin, dyes used in food and their safety concern, organic pigments with examples.	**15 Hours**

UNIT-III **Vibrational Spectroscopy** Simple harmonic oscillator, Hooke's law, energy level of simple harmonic oscillator model of diatomic molecule (final equations only), selection rules, zero point energy determination of force constant and qualitative relation between force constant and bond dissociation energies. Vibrational degrees of freedom of molecules (Linear and non linear). Fundamental and non-fundamental molecular vibrations; IR absorption positions of O,N and S containing functional groups; Effect of H-bonding, conjugation, resonance, Fingerprint region and its significance; application in functional group analysis.	**15 Hours**
UNIT-IV **Quantum chemistry** Photoelectric effect–Einstein's photo electric equation, wave particle duality, de-Broglie hypothesis, de-Broglie equation (derivation), experimental verification – Davisson – Germer experiment**.** **Photochemistry** Photochemical reactions, laws of photochemistry – Beer's law, Lambart's Law, Beer-Lambart's Law, Grothus-Draper Law and Einstein's Law of photochemical equivalence, quantum efficiency or yield, reasons, for high and low quantum efficiencies with examples, fluorescence, phosphorescence, photosensitization and chemiluminescence.	**15 Hours**

Reference Books:

1. Chemistry of elements-N.N.Greenwoodand A.E. Earnshaw, Butter worth Heinemann (1997).
2. Inorganic Chemistry IV edition; J. E. Huheey, E. A. Keiter and R. L. Keiter, Addison; Wesley (1993).
3. Inorganic Chemistry, II edition, D. F. Shriver, P. W. Atkins and C. H. Langford, ELBS; Oxford University Press, 1994.
4. Inorganic Electronic spectroscopy, A.B.P.Lever, Elsevier.(1968).
5. Molecular thermodynamics, Donald A. Mc Quarrie, John D. Simon University Science Books California, (1999).
6. Thermodynamics for Chemists, by S.Glasstone, East-West Press, NewDelhi,(1960).
7. Thermodynamics, by Rajaram anand Kuriacose, East-West Press,(1986).
5. Statistical Thermodynamics, M.C. Gupta (Wiley Eastern Ltd.)1993.
6. Elementary Statistical Thermodynamics, N.D.Smith, Plenum Press,NY,(1982).
7. Elements of Classical and Statistical Thermodynamics ,L.K.Nash, Addison-Wiley(1979).
8. Thermodynamics, Statistical Thermodynamics and Kinetics by Thomas Engel & Philip Reid, Pearson Educationinc.(2007)
9. Modern Electrochemistry Vol-1 and 2 J. O. M Bockris and A. K. N. Raddy, Plenum New York (1978)
10. An introduction to electrochemistry –Samuel Glastone East-West edition New Delhi(1942)
11. Text book of physical chemistry Samuel Glastone, 2 nd edition, Mac Millan India Ltd(1991)
12. Electrochemistry, Principles and applications, Edmund, C. Potter, Cleaver-Hume press London (1961).
13. Principles and applications of Electrochemistry -D.R.Crow 3rd edition Chapmanhall London (1988)

Program Name	**B.Sc. in Sugar Science& Technology**	Semester	**VI**
Course title	**CHEMISTRY-VIB (Theory)**		
Course Code	**DSC-24T**	No. of Credits	**03**
Contact hours	**60 Hours (4Hours/week)**	Duration of SEA/Exam	**3hours**
Formative Assessment Marks	**20**	Summative Assessment Marks	**80**

Course Pre-requisite(s):

Course Objectives:

Students learn about:

1. Various Rearrangement reactions.
2. Amino acids, peptides and Proteins
3. Organic Synthesis via enolates, Alcohols, Phenols
4. Raman spectroscopy
5. Corrosion prevention methods.

Course Objectives: Course Specific Outcomes:

After the completion of this course, the student would be able to

1. Understand objectives of Rearrangement reactions.
2. Able to know various Amino acids, peptides and Proteins
3. Know Organic Synthesis of alcohols & phenols.
4. Understand the Raman spectroscopy.
5. To understand corrosion process and its prevention.

Contents

UNIT-I **Rearrangement** Wagner-Meerwein, Fries, Wolff, Beckmann, Hofmann, Curtius, Schmidt rearrangements. Benzil-benzilic acid rearrangement, Wittig and Favorskii rearrangements, Baeyer-Villiger oxidation **Amino acids, peptides and Proteins** Definition, Classification, structure and stereochemistry (D and L) of amino acids, acid-base behaviour, iso-electric point and electrophoresis, dipeptides, synthesis of a dipeptide (Bergmann synthesis),classification of proteins based on composition and function, levels of protein structure (Primary, secondary and tertiary structure), protein denaturation and renaturation.	**15 Hours**

UNIT II **Organic Synthesis via enolates** Acidity of α-hydrogens, synthesis of ethylacetoacetate (EAA) by Claisen condensation and its mechanism, synthesis of diethyl malonate, keto-enol tautomerism of EAA Synthesis of following compounds using EAA and diethyl malonate: i) ketones ii) carboxylic acids iii) heterocyclic compounds iv) dicarboxylic acids. **Alcohols** Introduction and nomenclature of dihydric and trihydric alcohols, preparation of glycol from ethane, oxidative cleavage of ethylene glycol with lead tetra acetate and per iodic, pinacol-pinacolone rearrangement, preparation of glycerol from propene, synthesis and uses of nitroglycerine, composition and uses of dynamite and cordite, distinction between primary, secondary and tertiary alcohols by Lucas reagent. **Phenols** Classification and nomenclature, acidic character of phenol compared to alcohol and cyclohexenol,mechanismofFriesrearrangement,Claisenrearrangement,Elbspersulphate Oxidation and Lederer-Manasse reaction, synthesis and uses of n-hexylresorcinol and picric acid, structure and uses of Dettol.	**15 Hours**
UNIT III **Raman spectroscopy** Introduction, Quantum theory of Raman effect, theory of Raman spectra, Instrumentation, conditions for Raman Spectroscopy, equivalence of Beer-Lambert's Law of absorption in Raman Scattering, Characteristic parameters of Raman lines. Raman spectra of diatomic molecules, Rotational-Vibrational Raman spectra,Vibrational raman spectra of polyatomic molecules. Stokes and anti-Stokes lines; their intensity difference Rule of mutual exclusion principle, moment of inertia of diatomic molecules, Raman & IR spectroscopy complementary, Importance and applications of Raman spectroscopy.	**15 Hours**
UNIT IV **Corrosion and its Prevention:** Introduction, definition, Types of Corrosion, Corrosion rate, Factors affecting corrosion rate, Metallic factor-purity, electrode potential of metal, hydrogen over voltage, nature of corrosion product. Environmental Factors-Temperature, pH of the medium, humidity, presence of impurities, electrical conductivity of the medium, velocity of the medium, concentration of the medium. **Prevention of Corrosion:** Material selection-Metals and alloys, metal purification, non-metallic, Alteration of environment - Changing media, inhibitors, Design-wall thickness, Electroplating: Introduction, Electroplating of chromium (hard and decorative). Electroless plating: Introduction, distinction between electroplating and electroless plating processes. Electroless plating of copper.	**15 Hours**

Reference Books:

1.AdvancedOrganicChemistry-Reactions,Mechanism and Structure, Jerry March, John Wiley (2008).
2. Advanced Organic Chemistry, F.A. Carey and R.J. Sundberg, Plenum(1990).
3. A Guide Book to Mechanism of Organic Chemistry, Peter Sykes, Longman(2000).
4. Structure and Mechanism of Organic Chemistry, C.K. Ingold, Cornell University Press.
5. Organic Chemistry, R.T. Morrison and R.N.Boyd, Prentice-Hall(1998).
6. Modern Organic Reactions, H.O. House, Benjamin(1972).
7. Principles of Organic Synthesis, ROC Norman and J.M. Coxon, Blackie Academic and Professional (1996).
8. Organic Chemistry, Volumes I and II, I LFinar, Longman.(1999).
9. Medicinal Chemistry, A Kar, Wiley(2000).
10. Peptides Chemistry: A practical textbook, M.Bodansky,Springer-VerlagNY,1988.
11. Solid-phase peptide synthesis: A practical approach-E. Artherton & R.C. Sheppard, I R L, Oxford Univ. Press, 1989.
12. Peptides: Chemistry and Biology, N Selwadand H.-D.Jakubke,Wiley-VCH,2002.
13. Electrochemistry and Corrosion Science, Nestor Perez, Springer (india) Pvt. Ltd.,(2004).
14. Principles and Prevention of Corrosion, D.A. Jones ,Macmillan Publ. Co.,(1996)..
15. Essentials of Materials Science and Engineering, Donald R.Askeland, Thomson Learning, 5th Edition, (2006)
16. Introduction to Engineering Materials, B.K. Agarwal, Tata Mc GrawHill,1stEdition.

Program Name	**B Sc in Sugar Science& Technology**	Semester	**VI**
Course title	**CHEMISTRY-VI (Practical)**		
Course Code	**DSC-24P**	No. of Credits	**02**
Contact hours	**48 Hours (4 Hours/week)**	Duration of SEA/Exam	**4 hours**
Formative Assessment Marks	**10**	Summative Assessment Marks	**40**

Course Pre-requisite(s):

Course Objectives: Students learn about:

1. General techniques adopted for synthesis of organic complexes.
2. Quantitative analysis of organic compounds.

Course Objectives: Course Specific Outcomes:

After the completion of this course, the student would be able to

1. Understand objectives of synthesis of organic complexes.
2. Understand the Quantitative analysis of organic compounds.

Contents

Organic Synthesis: Preparation (one stage)

Gravimetric experiments:

1. Estimation of aluminium as aluminium oxide.
2. Estimation of Iron as ferric oxide.
3. Estimation of Barrium as Barrium sulphate.

Volumetric analysis:

4. Determination of percentage of iron in haematite ore
5. Determination of percentage of calcium in limestone
6. Determination of percentage of copper in brass

Physical Chemistry:

Conductometry:

7. Determination of concentration of given acids mixture (HCl+CH3COOH) conductometrically using standard NaOH.
8. Determine the partition coefficient of iodine between water & benzene .
9. To study the adsorption of acetic acid on animal charcoal

Potentiometry:

10. Potentiometric titration of $FeSO_4$ against $K_2Cr_2O_7$.
11. Potentiometric titration of FAS against $KMnO_4$.

Sugar Chemistry Practicals:

12. Determine the Titrable acidity in cane juice sample.
13. Determination of reducing sugars using 3,5-dinitrosalicylicacid.
14. Determine the Brix or R.I of sugar solution using Abbe's refractometer.
15. Determine the concentration of sugar solution using polarimeter.
16. Determination of phosphate content in cane juice

Reference Books:

1. Laboratory manual of Organic Chemistry-B.B.Dey, MV Sitaramanand TR Govindachari, Allied Publishers, New Delhi, (1996).
2. Practical Organic Chemistry-Mannand Saunders,(1980).
3. Text Book of Practical Organic Chemistry-A.I.Vogel,(1996).
4. Test Book of Quantitative Organic Analysis-A.I.Vogel,(1996).
5. Comprehensive practical organic chemistry: Preparation and quantitative Analysis
6. V.K. Ahluwalia, R. Aggarwal, Universities Press(India),2000.
7. An advanced course in practical chemistry, A.Ghoshal, B. Mahapatra and A.Kr.Nad, New central book agency, Calcutta, 2000.
8. Advanced practical organic chemistry, J. Mohan, Vol. I and II, Himalaya Publishing House, 1992.

Program Name	**B.Sc. in Sugar Science & Technology**	Semester	**VI**
Course title	**Compulsory-2: Practical Knowledge Skill :- INTERNSHIP FOR GRADUATE PROGRAMME (As Per UGC & AICTE)**		
Course Code		No. of Credits	**02**
Contact hours	**45 days**	Duration of SEA/Exam	
Formative Assessment Marks	**10**	Summative Assessment Marks	**40**

- Internship shall be Discipline Specific of 90 hours (2 credits) with duration 4-6 weeks.
- Internship may be full-time/part-time (full-time during semester holidays and part-time in the academic session)
- Internship mentor/supervisor shall avail work allotment during 6th semester for a maximum of 20 hours.
- The student should submit the final internship report (90 hours of Internship) to the mentor for completion of the internship.
- The detailed guidelines and formats shall be formulated by the universities separately as prescribed in accordance to UGC and AICTE guidelines.

Sugar Industry In-Plant Training	
Contents	
Unit – I Sugar cane cultivation practices – onsite training on farm	7 days
Unit – II **Sugar processing: -** Onsite training of sugar process for one week laboratory, cane Preparation & milling, juice clarification & evaporation, Pan boiling, Cooling and condensation system, Centrifugals, Sugar handling, Sugar gradation, Sugar storage, Molasses storage, waste water treatment	15 days
Unit – III **Sugar laboratory:** – various sampling and analysis technology used in sugar laboratory, Analysis of cane /juice/Bagasse/press Mud/Final molasses etc for its quality parameters and preparation of daily manufacturing report of sugar complex, Boiler feed water treatment, Boiler water treatment, waste water analysis	15 days
Unit – IV **Distillery:** - Molasses storage, various analytical control in distillery, Operation of fermentation /distillation/ packing & storage technology, ETP treatment of distillery spent wash	8 days

Reference Books:

1. Hand book of Cane Sugar Engineering, Hugot e., Elesevier Science publishing Co.Inc. New York.
2. Sugar Technology for Administrators in the Indian sugar factories; ManoharRao,P.J.; JayajiraoShinde Editor Bharatiya Sugar Jeevan DarshanLaxmi Rd. Pune.
3. Training manual for sugar mills. Mangal Singh; Somaiya publications Pvt.Ltd. Mumbai.
4. Efficient Management of sugar factories, Mangal Singh, Somaiya publication Pvt.Ltd. Bombay
5. Cane Sugar Manufacture in India, Kulkarni, D.P., The Sugar Technologists Association of India N.Delhi.
6. System of Technical control for cane sugar factories in India; Varma, N.C. The Sugar Technologists Association of India N.Delhi.
7. Industrial utilization of sugar cane and its Co-products , Manoharrao, P.J, ISPCK publishers &DistibutorsN.Delhi
8. Industrial Alcohol technology Handbook, NPCS board of consultant & Engineer.

B.Sc. Sugar Science & Technology Degree Examination
QUESTION PAPER PATTERN

Time: 03 Hours **Max. Marks: 80**

Instruction to candidates:

1. All questions are compulsory.

2. Answer all the questions in same answer book.

3. Draw neat labelled diagram and give equations wherever required.

	PART-A	
1.	**Answer any Ten of the following. (Three questions from each unit)**	**10×2= 20**
	a. **b.** **c.** **d.** **e.** **f.** **g.** **h.** **i.** **j.** **k.** **l.**	
	PART-B	
	Answer any Four of the following. (Two questions from each unit)	**4×5=20**
2. **3.** **4.** **5.** **6.** **7.**		
	PART-C	
	Answer any Four of the following. (One questions from each unit)	**4×10=40**
8. **9.** **10.** **11.** **12.**		

***Note:** 10 marks questions may be split into a&b.

Scheme of Evaluation for Practical Examination

	Particulars	Marks Allotted
1.	**Experimental preparation involving the following***	**30**
2.	**Journal (Record) Assessment**	**05**
3.	**Oral performance (viva-voce)**	**05**
	Total	**40**
*	Brief description & tabulation	05
	Diagrams / Formula / Equation	02
	Preparation of required solutions and experimental set-up	05
	Record of observation and performance of experiment	10
	Calculation including drawing graph	05
	Accuracy of result with unit	03

- Formative Assessment Marks will be given as per University guidelines.