

UNIVERSITY OF NORTH BENGAL



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Raja Rammohunpur, Dist: Darjeeling, Pin: 734013.

CHOICE BASED CREDIT SYSTEM (CBCS)

CHEMISTRY

PROGRAMME COURSE

Truncated Syllabus

(2nd, 4th & 6th Semester)

SYLLABUS LAYOUT FOR DSC PROGRAMME IN CHEMISTRY

SEMESTER	PAPER	TOPIC
SECOND	DSC-2	Section A: Physical Chemistry Section B: Organic Chemistry
FOURTH	DSC-4	Section A: Inorganic Chemistry Section B: Physical Chemistry
	SEC-2 [DSC]	Green Methods In Chemistry
SIXTH	SEC-4 [DSC]	Chemistry of Cosmetics & Perfumes
	DSE (DSC) - 2	Industrial Chemicals and Environment

SEMESTER-2

DSC-2 [SEMESTER-2]

CHEMICAL ENERGETICS, EQUILIBRIA & FUNCTIONAL GROUP ORGANIC CHEMISTRY-I

SECTION-A: PHYSICAL CHEMISTRY

Chemical Energetics: Basic Definitions and mathematical background. First Law, Enthalpy Functions, Relation between C_p and C_v , Joule-Thomson Experiment, Inversion of Temperature, Adiabatic Changes in State, Enthalpies of Chemical Changes, Important principles and definitions of thermochemistry. Hess's Law. The Second Law, Carnot Cycle and its efficiency. Variation of enthalpy of a reaction with temperature – Kirchhoff's equation. Statement of Third Law of thermodynamics. Entropy

Chemical Equilibrium: Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Le Chatelier's principle. Relationships between K_p , K_c and K_x for reactions involving ideal gases.

Ionic Equilibria: Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. pH scale, common ion effect. Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts.

Buffer solutions. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle.

SECTION -B: ORGANIC CHEMISTRY

Functional group approach for the following reactions: **Aromatic hydrocarbons** (benzene): Preparation from phenol, by decarboxylation, from acetylene. Reactions: (benzene): Electrophilic substitution: nitration, halogenation and sulphonation. Friedel Craft's reaction (alkylation and acylation)(Up to 4 Carbons on benzene). Side chain oxidation of alkyl benzenes (Up to 4 Carbons on benzene).

Alkyl and Aryl Halides: Alkyl Halides (Up to 5 Carbons). Types of Nucleophilic Substitution (S_N1 and S_N2) reactions. Preparation: from alkenes and alcohols. Reactions: hydrolysis,

nitrite & nitro formation. Williamson's ether synthesis: Elimination vs Substitution. Aryl Halides Preparation: (Chloro, bromo and iodo-benzene): from phenol, Sandmeyer & Gattermann reactions. Benzyne Mechanism: KNH_2/NH_3 (or $\text{NaNH}_2/\text{NH}_3$).

Alcohols and Phenols (Up to 5 Carbons): Alcohols: Preparation: Preparation of 1°, 2° and 3° alcohols: using Grignard reagent, Reduction of aldehydes, ketones, carboxylic acid and esters. Reactions: HX (Lucas test), esterification, oxidation (with alk. KMnO_4 , acidic dichromate). Oppeneaur oxidation. Diols: (Up to 6 Carbons) oxidation of diols. Pinacol Pinacolone rearrangement. Phenols: (Phenol) Preparation: Cumene hydroperoxide method, from diazonium salts. Reactions: Electrophilic substitution: Nitration, halogenation and sulphonation. Reimer- Tiemann Reaction, Gattermann-Koch Reaction.

Aldehydes and ketones: (aliphatic and aromatic): (Formaldehyde, acetaldehyde, acetone and benzaldehyde) Preparation: from acid chlorides and nitriles. Reactions – Reaction with HCN, ROH. Iodoform test. Aldol Condensation, Cannizzaro's reaction, Benzoin condensation, Clemensen reduction.

Reference Books:

- Graham Solomon, T.W., Fryhle, C.B & Snyder, S.A. Organic Chemistry, John Wiley & Sons (2014).
 - McMurry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.
 - Sykes, P. A Guidebook to Mechanism in Organic Chemistry, Orient Longman, New Delhi (1988).
 - Finar, I.L. Organic Chemistry (Vol. I & II), E.L.B.S.
 - Morrison, R.T. & Boyd, R.N. Organic Chemistry, Pearson, 2010.
 - Bahl, A. & Bahl, B.S. Advanced Organic Chemistry, S. Chand, 2010.
 - Barrow, G.M. Physical Chemistry Tata McGraw-Hill (2007).
 - Castellan, G.W. Physical Chemistry 4th Ed. Narosa (2004).
 - Kotz, J.C., Treichel, P.M. & Townsend, J.R. General Chemistry Cengage Learning India Pvt. Ltd., New Delhi (2009).
 - Mahan, B.H. University Chemistry 3rd Ed. Narosa (1998).
 - Petrucci, R.H. General Chemistry 5th Ed. Macmillan Publishing Co.: New York (1985).
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DSC-2 [PRACTICAL]

SECTION-A: PHYSICAL CHEMISTRY

(ANY TWO)

1. Determination of heat capacity of calorimeter for different volumes.
2. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
3. Measurement of pH of different solutions like aerated drinks/ fruit juices/shampoos/ soaps (use dilute solutions of soaps and shampoos to prevent damage to the glass electrode) using pH-meter.
4. (a) Preparation of buffer solutions: (ANY ONE)

(i) Sodium acetate-acetic acid

(ii) Ammonium chloride-ammonium hydroxide

Measurement of the pH of buffer solutions and comparison of the values with theoretical values.

Section B: ORGANIC CHEMISTRY

(ANY TWO)

1. Purification of organic compounds by crystallization (from water and alcohol) and distillation.
2. Criteria of Purity: Determination of melting and boiling points.
3. Preparations: Mechanism of various reactions involved to be discussed. Recrystallisation, determination of melting point and calculation of quantitative yields to be done.

(ANY ONE)

(a) Bromination of Phenol/Aniline

(b) Benzoylation of amines/phenols

(c) Oxime and 2,4-dinitrophenylhydrazone of aldehyde/ketone

Reference Books:

- Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996.
 - Mann, F.G. & Saunders, B.C. Practical Organic Chemistry Orient-Longman, 1960.
 - Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).
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SEMESTER-4

DSC-4 [SEMESTER-4]

TRANSITION METAL & COORDINATION CHEMISTRY, STATES OF MATTER & CHEMICAL KINETICS

SECTION-A: INORGANIC CHEMISTRY

Transition Elements (3d series)

General group trends with special reference to electronic configuration, variable valency, colour, magnetic properties, and ability to form complexes. Lanthanoids and actinoids: Electronic configurations, oxidation states, colour, magnetic properties, lanthanide contraction.

Coordination Chemistry

Valence Bond Theory (VBT): Inner and outer orbital complexes of Fe, Co, Ni and Cu (coordination numbers 4 and 6). Structural and stereoisomerism in complexes with coordination numbers 4 and 6. Drawbacks of VBT. IUPAC system of nomenclature.

Crystal Field Theory

Crystal field effect, octahedral symmetry. Crystal field stabilization energy (CFSE), Crystal field effects for weak and strong fields. Tetrahedral symmetry. Factors affecting the magnitude of Δ_o . Spectrochemical series. Comparison of CFSE for O_h and T_d complexes, Jahn-Teller distortion.

SECTION - B: PHYSICAL CHEMISTRY

Gases

Postulates of Kinetic Theory of Gases and derivation of the kinetic gas equation. Deviation of real gases from ideal behaviour, compressibility factor, causes of deviation. van der Waals equation of state for real gases. Boyle temperature (derivation not required). Critical phenomena, critical constants and their calculation from van der Waals equation. Andrews isotherms of CO_2 . Maxwell Boltzmann distribution laws of molecular velocities and

molecular energies (graphic representation – derivation not required) and their importance. Temperature dependence of these distributions. Most probable, average and root mean square velocities (no derivation). Collision cross section, collision number, collision frequency, collision diameter and mean free path of molecules. Viscosity of gases and effect of temperature and pressure on coefficient of viscosity (qualitative treatment only).

Liquids

Surface tension and its determination using stalagmometer. Viscosity of a liquid and determination of coefficient of viscosity using Ostwald viscometer. Effect of temperature on surface tension and coefficient of viscosity of a liquid (qualitative treatment only).

Chemical Kinetics

The concept of reaction rates. Effect of temperature, pressure, catalyst and other factors on reaction rates. Order and molecularity of a reaction. Derivation of integrated rate equations for zero, first and second order reactions. Half-life of a reaction. General methods for determination of order of a reaction. Concept of activation energy and its calculation from Arrhenius equation. Theories of Reaction Rates: Collision theory and Activated Complex theory of bimolecular reactions.

Reference Books:

- Barrow, G.M. Physical Chemistry Tata McGraw-Hill (2007)
 - Castellan, G.W. Physical Chemistry 4th Ed. Narosa (2004)
 - Kotz, J.C., Treichel, P.M. & Townsend, J.R. General Chemistry Cengage Learning India Pvt. Ltd., New Delhi (2009).
 - Mahan, B.H. University Chemistry 3rd Ed. Narosa (1998)
 - Petrucci, R.H. General Chemistry 5th Ed. Macmillan Publishing Co.: New York (1985).
 - Cotton, F.A. & Wilkinson, G. Basic Inorganic Chemistry, Wiley
 - Shriver, D.F. & Atkins, P.W. Inorganic Chemistry, Oxford University Press.
 - Wulfsberg, G. Inorganic Chemistry, Viva Books Pvt. Ltd
 - Rodgers, G.E. Inorganic & Solid State Chemistry, Cengage Learning India Ltd., 2008
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DSC-4: PRACTICAL

Section A: Inorganic Chemistry

(a) Semi-micro qualitative analysis (using H₂S or other methods) of mixtures - not more than four ionic species (two anions and two cations, excluding insoluble salts) out of the following:

Cations : NH₄⁺, Pb²⁺, Bi³⁺, Cu²⁺, Cd²⁺, Fe³⁺, Al³⁺, Co²⁺, Ni²⁺, Mn²⁺, Zn²⁺, Ba²⁺, Sr²⁺, Ca²⁺, K⁺

Anions : S²⁻, NO₃⁻, Cl⁻, Br⁻, I⁻, NO₃⁻, SO₄²⁻, PO₄³⁻, BO₃³⁻, F⁻ (Spot tests should be carried out wherever feasible)

(b) (ANY ONE)

1. Estimate the amount of nickel present in a given solution as bis(dimethylglyoximate) nickel(II) or aluminium as oximate in a given solution gravimetrically.
2. Estimation of (i) Mg²⁺ or (ii) Zn²⁺ by complexometric titrations using EDTA.
3. Estimation of total hardness of a given sample of water by complexometric titration.

Section B: Physical Chemistry

(ANY TWO)

1. Determination of Density of a liquid.
2. (a) Determination of the surface tension of a liquid or a dilute solution using a stalagmometer.
(b) Study of the variation of surface tension of a solution with concentration
3. (a) Determination of the coefficient of viscosity of a liquid or dilute solution using an Ostwald's viscometer.
(b) Study of the variation of viscosity of an aqueous solution with concentration of solute.
4. Chemical Kinetics

Study the kinetics of the following reactions. (ANY ONE)

- (a) Acid hydrolysis of methyl acetate with hydrochloric acid
- (b) Saponification of ethyl acetate.

Reference Books:

- Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012.
 - Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.
 - Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand
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SEC-2: GREEN METHODS IN CHEMISTRY

(Credits: 02)

Theory and Hand-on Experiments

Definitions of Green Chemistry. Brief introduction of twelve principles of Green Chemistry, with examples,

Special emphasis on atom economy and green solvents.

Green Chemistry and alternative sources of energy.

The following Real world Cases in Green Chemistry should be discussed:

1. Surfactants for carbon dioxide – Replacing smog producing and ozone depleting solvents with CO₂ for precision cleaning and dry cleaning of garments.
2. Right fit pigment: Synthetic azo pigments to replace toxic organic and inorganic pigments.

GREEN METHODS IN CHEMISTRY PRACTICALS:

ANY TWO:

1. Preparation and characterization of biodiesel from vegetable oil.
2. Bromination of Anilide Using Green Approach.
3. Preparation of Benzilic acid by using Green Approach.
4. Solvent free, microwave assisted one pot synthesis of phthalocyanine complex of copper(II).

Reference Books:

- Anastas, P.T. & Warner, J.K. *Green Chemistry- Theory and Practical*, Oxford University Press (1998).
 - Matlack, A.S. *Introduction to Green Chemistry*, Marcel Dekker (2001).
 - Cann, M.C. & Connely, M.E. *Real-World cases in Green Chemistry*, American Chemical Society, Washington (2000).
 - Ryan, M.A. & Tinnesand, M. *Introduction to Green Chemistry*, American Chemical Society, Washington (2002).
 - Sharma, R.K.; Sidhwani, I.T. & Chaudhari, M.K. *Green Chemistry Experiments:A monograph* I.K. International Publishing House Pvt Ltd. New Delhi, Bangalore.
 - Lancaster, M. *Green Chemistry: An introductory text* RSC publishing, 2nd Edition.
 - Sidhwani, I.T., Saini, G., Chowdhury, S., Garg, D., Malovika, Garg, N. Wealth from waste: A green method to produce biodiesel from waste cooking oil and generation of useful products from waste further generated "A Social AwarenessProject", *Delhi University Journal of Undergraduate Research and Innovation*,1(1): 2015.
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SEMESTER-6

SEC- 4[DSC]

CHEMISTRY OF COSMETICS & PERFUMES

(Credits: 2)

THEORY

A general study including preparation and uses of the following:

Hair dye, hair spray, shampoo, face powder, talcum powder, Nail Enamel, creams (cold, vanishing and shaving creams), antiperspirants and artificial flavours.

Essential oils and their importance in cosmetic industries with reference to sandalwood oil, eucalyptus, rose oil, 2-phenyl ethyl alcohol, Jasmone.

PRACTICAL (ANY TWO)

1. Preparation of talcum powder.
2. Preparation of shampoo.
3. Preparation of face cream
4. Preparation of nail polish and nail polish remover.

Reference Books:

- Stocchi, E. Industrial Chemistry, Vol-I, Ellis Horwood Ltd. UK (1990).
• Jain, P.C. & Jain, M. Engineering Chemistry Dhanpat Rai & Sons, Delhi. Sharma, B.K. & Gaur, H. Industrial Chemistry, Goel Publishing House, Meerut (1996)
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DSE-2 [DSC]

INDUSTRIAL CHEMICALS AND ENVIRONMENT

(Credits: Theory-04, Practicals-02)

Industrial Gases and Inorganic Chemicals

Industrial Gases: Large scale production, uses, storage and hazards in handling of the following gases: oxygen, nitrogen, argon, neon, helium, hydrogen, acetylene, carbon monoxide, chlorine, fluorine, sulphur dioxide and phosgene.

Inorganic Chemicals: Manufacture, application, analysis and hazards in handling the following chemicals: hydrochloric acid, nitric acid, sulphuric acid, caustic soda, common salt, borax, bleaching powder, hydrogen peroxide, potash alum, chrome alum, potassium dichromate and potassium permanganate.

Environment and its segments

Ecosystems. Biogeochemical cycles of carbon, nitrogen and sulphur.

Air Pollution: Major regions of atmosphere. Chemical and photochemical reactions in atmosphere. Air pollutants: types, sources, particle size and chemical nature; Photochemical smog: its constituents and photochemistry. Environmental effects of ozone, Major sources of air pollution.

Pollution by SO_2 , CO_2 , CO , NO_x , H_2S and other foul smelling gases.

Effects of air pollution on living organisms and vegetation. Greenhouse effect and Global warming, Ozone depletion by oxides of nitrogen, chlorofluorocarbons and Halogens, removal of sulphur from coal. Control of particulates.

Water Pollution: Hydrological cycle, water resources, aquatic ecosystems, Sources and nature of water pollutants, Techniques for measuring water pollution,

Water purification methods. Effluent treatment plants (primary, secondary and tertiary treatment). Industrial effluents from the following industries and their treatment: electroplating, textile, tannery, dairy, petroleum and petrochemicals, agro, fertilizer, etc. Sludge disposal.

Industrial waste management, incineration of waste. Water treatment and purification (reverse osmosis, electro dialysis, ion exchange). Water quality parameters for waste water, industrial water and domestic water.

Energy & Environment

Sources of energy: Coal, petrol and natural gas. Nuclear Fusion / Fission, Solar energy, Hydrogen, geothermal, Tidal and Hydel, etc.

Nuclear Pollution: Disposal of nuclear waste, nuclear disaster and its management.

Reference Books:

- E. Stocchi: *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK.
 - R.M. Felder, R.W. Rousseau: *Elementary Principles of Chemical Processes*, Wiley Publishers, New Delhi.
 - J. A. Kent: *Riegel's Handbook of Industrial Chemistry*, CBS Publishers, New Delhi.
 - S. S. Dara: *A Textbook of Engineering Chemistry*, S. Chand & Company Ltd. New Delhi.
 - K. De, *Environmental Chemistry*: New Age International Pvt., Ltd, New Delhi.
 - S. M. Khopkar, *Environmental Pollution Analysis*: Wiley Eastern Ltd, New Delhi.
 - S.E. Manahan, *Environmental Chemistry*, CRC Press (2005).
 - G.T. Miller, *Environmental Science* 11th edition. Brooks/ Cole (2006).
 - Mishra, *Environmental Studies*. Selective and Scientific Books, New Delhi (2005).
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DSE -4

INDUSTRIAL CHEMICALS & ENVIRONMENT- Practical

ANY TWO:

1. Measurement of chloride, sulphate and salinity of water samples by simple titration method (AgNO_3 and potassium chromate).
2. Estimation of total alkalinity of water samples (CO_3^{2-} , HCO_3^-) using double titration method.
3. Measurement of dissolved CO_2 .
4. Study of some of the common bio-indicators of pollution.
5. Estimation of SPM in air samples.
6. Preparation of borax/boric acid.

Reference Books:

- E. Stocchi: *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK.
 - R.M. Felder, R.W. Rousseau: *Elementary Principles of Chemical Processes*, Wiley Publishers, New Delhi.
 - J. A. Kent: *Riegel's Handbook of Industrial Chemistry*, CBS Publishers, New Delhi.
 - S. S. Dara: *A Textbook of Engineering Chemistry*, S. Chand & Company Ltd. New Delhi.
 - K. De, *Environmental Chemistry*: New Age International Pvt., Ltd, New Delhi.
 - S. M. Khopkar, *Environmental Pollution Analysis*: Wiley Eastern Ltd, New Delhi.
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