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DEPARTMENT OF CHEMISTRY
SEMESTER – II

B.SC. in Industrial Chemistry

DISCIPLINE SPECIFIC CORE COURSE – 4: (DSC-4) Fossil Fuels and Cleansing Agents

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Fossil Fuels and Cleansing Agents (DSC-4: Industrial Chemistry -II)	**04**	**02**	**--**	**02**	**Physics, Chemistry, Mathematics, in Class XII**	**---**

Learning Objectives

The Learning Objectives of this course are as follows:

- To understand the different aspects of industrial processes of fossil fuels in detail.
- To know the importance of renewable cleaner energy sources and optimise the use of non -renewable fossil fuels.
- To enhance the reasoning and to understand the mechanical part of the industry.

Learning outcomes

By the end of the course, the students will be able to:

- Explain about fuels, composition, carbonization of coal, liquefaction, and coal tar-based chemicals and layout for key processes in oil refining.
- Recognize the role of petroleum and petrochemical industry, composition, applications, process-cracking. Increasing demand for non-petroleum fuels, synthetic fuels.
- Analyse different fossil fuel products and processes
- Categorize with types of oils, estimate rancidity, saponification value, iodine number and account for superiority of synthetic detergents.

SYLLABUS OF DSC-4

UNIT – I: Fuel Chemistry and Introduction to Coal (5 Weeks)

Review of energy sources (renewable and non-renewable). Classification of fuels and their calorific value. Introduction of coal, uses of coal (fuel and non-fuel) in various industries (at least three examples), its types and composition, carbonization of coal. Coal gas, producer gas and water gas—composition and their uses, uses of coal-tar based chemicals, Requisites of a good metallurgical coke, Coal liquefaction and Solvent refining.

UNIT – II: Petroleum and Petrochemical Industry (6 Weeks)

Composition of crude petroleum, Refining and different types of petroleum products and their applications. Fractional distillation (principle and process), Cracking (thermal and catalytic cracking), Reforming petroleum and non-petroleum fuels (LPG,CNG,LNG, bio-gas, biofuels derived from biomass), fuel from waste, synthetic fuels (gaseous and liquids), clean fuels

UNIT – III: Oils and Fats (4 Weeks)

Classification of oils, hydrogenation of oils, rancidity, saponification value, iodine number, acid value, soap and synthetic detergent, preparation of soap and detergent, different types of soap and their composition, surfactants (LAS, ABS, LABS).

Practical

(Credits:02, Laboratory periods: 60)

1. Determination of alkali in water samples and soaps.
2. Determination of iodine value of the oils/ fats.
3. Determination of saponification value of the oils/ fats.
4. Determination of acid value of the oils/ fats.
5. To determine the moisture content of different fuels.
6. Estimation of hardness of water by titration with soap solution.
7. Preparation of soap.
8. Preparation of biodiesel from waste cooking oil and its characterization.
9. To compare the viscosity of biodiesel and vegetable oil.
10. To determine the density of the given fuel sample.
11. Characterization of different petroleum products using UV and IR.

Essential/recommended readings

Theory:

1. Vermani, O. P.; Narula, A. K. (2004), **Industrial Chemistry,** Galgotia Publications Pvt. Ltd., New Delhi.

2. Bhatia, S. C. (2004), **Chemical Process Industries**, Vol. I & II, CBS Publishers, New Delhi.
3. Jain, P. C.; Jain, M. (2013), **Engineering Chemistry**, Dhanpat Rai& Sons, Delhi.
4. Gopalan, R. Venkappayya, D.; Nagarajan, S. (2004), **Engineering Chemistry**, Vikas Publications.
5. Sharma, B. K. (1997), **Engineering Chemistry**, Goel Publishing House, Meerut.

Practical:

1. Verma, S. and Goyal, R. K. (2021) **Fuel Chemistry Theory and Practical**,1st Edition Aaryush Publications, Muzaffarnagar (U.P.)
2. Ahluwalia, V. K. and Aggarwal, R. **Comprehensive Practical Organic Chemistry, Preparation and Quantitative Analysis** ,University Press, New Delhi.
3. Sharma, R.K., Sidhwani, I.T.,Chaudhari,M.K. (2013),**Green Chemistry Experiments: A monograp**h, I.K. International Publishing House Pvt Ltd. New Delhi.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE –DSC 5: Periodic Properties and Chemical bonding

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Periodic Properties and Chemical bonding (DSC-5: Chemistry -II)	04	02	--	02	Physics, Chemistry, Mathematics, in Class XII	

Learning Objectives

The Learning Objectives of this course are as follows:

- To discuss the periodicity in properties with reference to the s, p and d block, which is necessary in understanding their group chemistry.
- To provide basic knowledge about ionic, covalent and metallic bonding underlining the fact that chemical bonding is best regarded as a continuum between the three cases.
- To give an overview of hydrogen bonding and van der Waal's forces which influence the melting points, boiling points, solubility and energetics of dissolution of compounds

Learning outcomes

By the end of the course, the students will be able to:

- Explain periodicity in ionization enthalpy, electron gain enthalpy, electronegativity and enthalpy of atomization.
- Predict variability in oxidation state, colour, metallic character, magnetic and catalytic properties and ability to form complexes
- Illustrate the concept of lattice energy using Born-Landé expression.
- Draw Born Haber Cycle and analyse reaction energies.
- Draw the plausible structures and geometries of molecules using VSEPR theory.
- Draw MO diagrams (homo- & hetero-nuclear diatomic molecules).
- Explain the importance and applications of hydrogen and van der Wall bonding.

SYLLABUS OF DSC- 5

UNIT – I: Periodic Properties (6 Weeks)

Electronic configurations of the atoms. Stability of half-filled and completely filled orbitals, concept of exchange energy, inert pair effect.

General group trends of s, p and d block elements with special reference to Ionization Enthalpy, Electron Gain Enthalpy, Electronegativity, Enthalpy of Atomization, oxidation state, colour, metallic character, magnetic and catalytic properties, ability to form complexes

UNIT – II: Chemical bonding (9 Weeks)

Ionic Bonding: General characteristics of ionic bonding, Lattice Enthalpy and Solvation Enthalpy and their relation to stability and solubility of ionic compounds, Born-Lande equation for calculation of Lattice Enthalpy (no derivation), Born-Haber cycle and its applications, polarizing power and polarizability, Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character.

Covalent Bonding: Valence Bond Approach, Hybridization and VSEPR Theory with suitable examples, Concept of resonance and resonating structures in various inorganic and organic compounds, Molecular Orbital Approach: Rules for the LCAO method, bonding, nonbonding and antibonding MOs and their characteristics for s-s, s-p and p-p combinations of atomic orbitals, MO treatment of homonuclear diatomic molecules of 1^{st} and 2^{nd} periods (including idea of s-p mixing) and heteronuclear diatomic molecules such as CO, NO and NO^{+}.

Brief introduction to Metallic Bonding, Hydrogen Bonding, van der Waal's Forces

Practicals:

(Credit:02, Laboratory periods: 60)

1. Preparation of standard solutions.
2. Estimation of Sodium carbonate with HCl.
3. Estimation of oxalic acid by titrating it with $KMnO_4$.
4. Estimation of Mohr's salt by titrating it with $KMnO_4$.
5. Estimation of water of crystallization in Mohr's salt by titrating with $KMnO_4$.
6. Estimation of Fe (II) ions by titrating it with $K_2Cr_2O_7$ using internal and external indicators.
7. Estimation of Cu (II) ions iodometrically using $Na_2S_2O_3$.
8. Chromatographic separation of mixture of metal ions Cu^{2+}, Cd^{2+} or Ni^{2+}, Co^{2+}.
9. Estimation of Fe (II) ions by titrating it with $K_2Cr_2O_7$ using
    a. internal indicator
    b. external indicator

10. Estimation of Cu (II) ions iodometrically using $Na_2S_2O_3$.
11. Paper Chromatographic separation of mixture of metal ions
    a. Cu^{2+}, Cd^{2+}
    b. Ni^{2+} , Co^{2+}
12. Any suitable experiment (other than the listed ones) based upon neutralisation/redox reactions.

Essential/recommended readings

Theory:

1. Huheey, J.E.; Keiter, E.A., Keiter; R. L.; Medhi, O.K. (2009), **Inorganic Chemistry- Principles of Structure and Reactivity**, Pearson Education
2. Shriver, D.D.; Atkins, P.; Langford, C.H. (1994), **Inorganic Chemistry** 2nd Ed., Oxford University Press.
3. Atkins, P.W.; Overton, T.L.; Rourke, J.P.; Weller, M.T.; Armstrong, F.A. (2010), **Inorganic Chemistry**, 5th Edition, W. H. Freeman and Company.
4. Lee, J.D.; (2010), **Concise Inorganic Chemistry**, Wiley India
5. Douglas, B.E.; McDaniel, D.H.; Alexander, J.J. (1994), **Concepts and Models of Inorganic Chemistry**, John Wiley & Sons.
6. Wulfsberg, G (2002), **Inorganic Chemistry**, Viva Books Private Limited.
7. Miessler, G.L.; Fischer P.J.; Tarr, D. A. (2014), **Inorganic Chemistry**, 5th Edition, Pearson.

Practical:

1. Jeffery, G.H.; Bassett, J.; Mendham, J.; Denney, R.C. (1989), **Vogel's Textbook of Quantitative Chemical Analysis**, John Wiley and Sons.