2. Parker T.J. and Haswell W.A. Textbook of Zoology Vertebrates. VII Edition, Volume II
3. Darlington P.J. The Geographical Distribution of Animals, R.E. Krieger Pub. Co.
4. Kaur I., Uniyal P.L. (2019). *Text Book of Gymnosperms*. New Delhi, Delhi: Daya Publishing House.
5. Vashistha, B.R., Sinha, A.K., Kumar, A. (2010). *Botany For Degree Students, Gymnosperms.* New Delhi, Delhi: S Chand Publication.
6. Bhatnagar, S.P., Moitra, A. (1996). *Gymnosperms*. New Delhi, Delhi: New Age International (P) Ltd Publishers.
7. Singh, G., (2018). *Plant Systematics: Theory and Practice*. Oxford & IBH Publishing Co. Pvt. Ltd.

Suggested readings

1. Ennos, R., & Sheffield, E., (2000). Plant Life. UK: University Press, Cambridge.
2. Ingrowille, M., (1992). Diversity and Evolution of land plants. Chapman and Hall
3. Wilson, E. O., (1998). Biodiversity. National Academic Press.
4. Pough H. Vertebrate life. VIII Edition, Pearson International.
5. Simpson, M.G. (2010). *Plant Systematics*. Elsevier Academic Press, San Diego, CA, U.SA

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

DISCIPLINE SPECIFIC CORE COURSE –6 :

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		
Chemical Energetics, Ionic Equilibria and Nanomaterials, (BS-DSC-203))	**4**	**2**	**0**	**2**	Class XII pass with Biology and chemistry, as one of the papers in Class XII	**Nil**

Learning Objectives

The Learning Objectives of this course are as follows:

- To introduce materials at nanoscale, their preparation, characterization techniques and applications in real life.
- Develops basic understanding of the chemical energetics, laws of thermodynamics, chemical and ionic equilibrium.
- It provides basic understanding of the behaviour of electrolytes and their solutions.
- The course will also cover thermodynamic studies with the calculation of energies and interaction of biomolecules withtheir neighbouring environment.

Learning outcomes

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

- Understand the concept of nano-dimensions.
- Know the various methods of preparation of nanomaterials.
- Know the different characterization techniques used for the analysis of nanomaterials andunderstand the basic principle behind these techniques.
- Understand the diverse properties of nanostructures.
- Appreciate the real-world applications of nanomaterials.
- Understand the laws of thermodynamics, basic principles of thermochemistry andequilibria and successfully extend the concepts learnt in this course to biological systems.
- Understand concept of pH and its effect on the various physical and chemical propertiesof the compounds.
- Use the concepts learnt to predict feasibility of chemical reactions and to study thebehaviour of reactions in equilibrium.
- Explain the concept of ionization of electrolytes with emphasis on weak acid and baseand hydrolysis of salt.
- Apply the concepts of pH and electrolytes while studying other chemistry courses andeveryday life.

SYLLABUS OF DSC-3

UNIT – I Nanomaterials of Biological importance (15 Hours)

Overview of nanomaterials, classification, properties, role of size, methods of synthesis (Chemical methods: chemical reduction, coprecipitation, sol-gel, microemulsions or reverse micelles, solvothermal synthesis, Green or biological methods using bacteria, Fungi, etc, Plants based methods using tea leaves, cinnamon bark, etc), characterization techniques (UV-Vis, IR, SEM, TEM, XRD), optical properties of gold and silver metallic nanoparticles, concept of surface plasmon resonance, carbon nanotubes, inorganic nanowires, quantum dots & semiconductor nanoparticles, metal-based nanostructures (Iron Oxide & ZnO nanoparticles), polymer-based nanostructures, protein-based Nanostructures, natural and artificial nanomaterials, bionanomaterials and bio-nanocomposites, bioinorganic nanomaterials, DNA and its nanomaterials, biomimetics, self-assembled nanostructures, control of nanoarchitecture, Applications of nanomaterials in drug delivery, tissue engineering,

medicine, orthopaedics, bioimaging, dental implants and biosensors

UNIT – II Chemical energetics (05 Hours)

Review of laws of thermodynamics, important principles and definitions of thermochemistry, concept of standard state and standard enthalpies of formations, enthalpy of neutralization, integral and differential enthalpies of solution and dilution, calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data, Statement of third law of thermodynamics and calculation of absolute entropies of substances.

UNIT – III Ionic Equilibria (10 Hours)

Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, Ostwald's dilution law, ionization constant and ionic product of water, ionization of weak acids and bases, pH scale, common ion effect, salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions and their applicationsin biological systems, Henderson-Hasselbalch equation. Solubility and solubility product ofsparingly soluble salts – applications of solubility product principle.

Practical component: TOTAL HOURS: 60

1. Synthesis of silver nanoparticles (AgNPs) by chemical reduction method and theirspectroscopic characterization using UV-visible spectrophotometer.
2. Green synthesis of silver nanoparticles (AgNPs) using soluble starch or cinnamon barkand their characterization using UV-visible spectroscopy.
3. Phytochemicals mediated synthesis of gold nanoparticles (AuNPs) using tea leaves and tostudy the effect of size on color of gold nanoparticles.
4. Preparation of magnetic nanoparticles (MNPs) of Fe_3O_4 using green tea leaf extract.
5. Synthesis of pure ZnO and Cu-doped ZnO nanoparticles by precipitation method and itscharacterization using UV-visible spectroscopy.
6. XRD pattern of nanomaterials and estimation of particle size. (Students can be providedwith XRD patterns of known materials and asked to interpret the data.)
7. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
8. Determination of integral enthalpy (endothermic and exothermic) solution of salts.
9. Preparation of buffer solutions: (i) Sodium acetate-acetic acid or (ii) Ammoniumchloride-ammonium acetate.
10. Measurement of the pH of buffer solutions and comparison of the values with theoreticalvalues.

11. pH metric titration of (i) strong acid with strong base, (ii) weak acid with strong base anddetermination of dissociation constant of a weak acid.

Essential/recommended readings

1. Atkins, P., Overton, T., Rourke, J., Weller, M. & Armstrong, F. (2011-12).
2. Shriver and Atkins' Inorganic Chemistry. Oxford, UK: Oxford University Press.
3. Poole Jr.; Charles P.; Owens, Frank J. (2003), Introduction to Nanotechnology, JohnWiley and Sons.
4. Malhotra, P.; Gulati, S., Novel Inorganic Solids and Nanomaterials, (2022) I.K.International Pvt Ltd.
5. Gulati, S., Sharma, J. L., Manocha, S. (2017). Practical Inorganic Chemistry. New Delhi,India: CBS publishers and distributors Pvt. Ltd.
6. Orbaek, W.; McHale, M.M.; Barron, A. R.; Synthesis and Characterization of Silver Nanoparticles for An Undergraduate Laboratory, J. Chem. Educ. 2015, 92, 339−344.
7. Gulati, S.; Shukla, S.; Kumar, S., Practical Green Chemistry, Strategies, Tools &Experiments, SKP Publishers and Distributors, 2019.
8. Shukla, S.; Gulati, S.; Kumar, S., A textbook of Green Chemistry, Benign by Design,SKP Publishers and Distributors, 2019.
9. Ghorbani H.R.; Mehr, F.P; Pazoki, H; Rahmani, B.M.; Synthesis of ZnO Nanoparticlesby Precipitation Method, Orient J Chem 2015, 31(2).
10. Kumar, S., Kapoor, V, Gulati, S, Experiments in Physical Chemistry, (2017), Book AgeSeries.
11. Kapoor, K.L. (2017). A Textbook of Physical Chemistry, Thermodynamics and ChemicalEquilibrium, Vol. 2. India: McGraw-Hill Education.
12. Khosla, B. D., Garg, V. C., Gulati, A. (2011). Senior Practical Physical Chemistry. NewDelhi, India: R. Chand & Co.
13. Rastogi, R. P., Mishra, R. R. (2009). *An Introduction to Chemical Thermodynamics*.India: Vikas Publication.
14. Atkins, P.W.; Paula, J.de. (2014), Atkin's Physical Chemistry Ed., 10th Edition, OxfordUniversity Press.
15. Ball, D. W. (2017), Physical Chemistry, 2nd Edition, Cengage Learning, India.
16. Castellan, G. W. (2004), Physical Chemistry, 4th Edition, Narosa.

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