# Indian Institute of Science Education and Research Berhampur

## BS-MS (Dual Degree)

## Course Curriculum

## 2016-17-I Semester

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## BS-MS (Dual Degree) COURSE CURRICULUM

## CORE COURSES

### I Semester

| Course No. | Course Name | Lec Hr | Lab Hr | Tut Hr | SS Hr | Credit |
|---|---|---|---|---|---|---|
| BIO 101 | Biomolecules and The Origin of Life | 3 | 0 | 1 | 6 | 3 |
| BIO 103 | General Biology Laboratory I | 0 | 3 | 0 | 0 | 1 |
| CHM 101 | General Chemistry | 3 | 0 | 1 | 6 | 3 |
| CHM 103 | General Chemistry Laboratory | 0 | 3 | 0 | 0 | 1 |
| CS 101 | Introduction to Computers | 2 | 1 | 0 | 6 | 3 |
| HSS 103 | Basics of Communication Skills | 1 | 0 | 0 | 2 | 1 |
| MTH 101 | Calculus of One Variable | 3 | 0 | 1 | 6 | 3 |
| PHY 101 | Mechanics | 3 | 0 | 1 | 6 | 3 |
| PHY 103 | General Physics Laboratory I | 0 | 3 | 0 | 0 | 1 |
| **Total** | | **15** | **10** | **4** | **32** | **19** |

**NOTE**:

Lec Hr: Lecture Hours per week; Lab Hr: Laboratory Hours per week;
Tut Hr: Tutorial Hours per week; SS Hr: Self Study Hours per week

- Every Lecture Hour is associated with a certain number of Self Study Hours
- Tutorials will have no credits.
- Typically, every regular course will have 3 lecture hours per week
- Number of Credits = [(Lec Hr + Lab Hr + SS Hr)/3]
- All laboratory work (including notebook writing) should be completed inside the laboratory

For example, CHM 222 has 3 Lec Hr and 6 SS Hr. So, Number of Credits = [(3+0+6)/3] = 3

## BIO 101: Biomolecules and the Origin of Life (3 Credits)

### *Learning Objectives*:

This course aims at orienting the students to important small and big molecules that are basic building block of biological systems and their assembly into further complex compounds structure and an understanding about the origin of life on the Earth.

### *Course Contents*:

Elemental Composition of Biomolecules; Properties of Water, hydrogen bonding and its biochemical properties; Concept of pH, pKa and buffers; Basic structure and function of Biological Macromolecules: Amino acids, Nucleotides and Monosaccharides, fatty acids (building blocks) Proteins, Nucleic Acids, Carbohydrates and Lipids (polymers); Origin of Life- Spontaneous generation; Pasteur and Miller experiments; An Introduction to plant and animal cell - Compare and contrasts, Cell organelles.

### *Suggested Books*:

- Principles of Biochemistry: Lehninger, Nelson and Cox; W.H. Freeman; 5th edition; 2008.
- Molecular Biology of the Cell: Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter; New York: Garland Science; 5$^{th}$ edition; 2008
- NCERT basic Biology books

## BIO 103: General Biology Laboratory I (1 Credit)

- Introduction to lab instruments and general lab practices
- Buffer preparation - amino acid titration (Glycine)
- Carbohydrate estimation
- Protein estimation – Bradford and Lowry
- Saponification and use of detergents
- Visualization of cells
- Histology slides
- Osmosis
- Model preparation

**CHM 101: General Chemistry (3 Credits)**

***Learning Objectives*:**

This is an introductory course that covers fundamental concepts in general chemistry. The course will focus on a conceptual understanding of the principles of chemistry. Topics of discussion will include atomic structure, periodicity of elemental properties, chemical bonding and reactivity, electronic effects in organic molecules and properties of gases.

***Course Contents*:**

*Atomic Structure, Periodic Table and the Concept of Periodicity:* Atomic structure; Vector model of atom and electronic configuration of polyelectronic atoms; Atomic structure as the basis for periodicity; Applications of the periodic law. Effective nuclear charge; Slater's rules, screening effect. Size of atoms and ions, ionization energies; electronegativity, electron affinity; periodic properties of elements and periodic trends, diagonal relationships; Fajan's rules.

*Chemical Bonding:* Lewis theory; Formal charges, resonance and rationalization of structures; VSEPR theory and shapes of molecules. Applications of VSEPR theory in predicting trends in bond lengths and bond angles. Molecular orbital theory of homo and heterodiatomic molecules, concept of HOMO, LUMO and SOMO. The solid state structures, lattice energy and Born-Haber cycle.

*Electronic effects:* Dipole moment, inductive and field effects, polarizability, resonance effect, hyper-conjugation; fundamental aspects of aromaticity.

*Acids and Bases:* Various theories of Acids and bases; Brønsted acids and bases. Protonic acids, gas-phase *vs* solution behavior of acids. Lewis acidity, 'Hard' and 'Soft' Acids and Bases. Solid acids. Concepts of pH, $pK_a$, $pK_b$ as applied in different chemical structures.

*Properties of the Gaseous State*: Gas Laws, equation of states, critical constants, law of corresponding states, Distribution of molecular speeds and its applications, mean-free path, compressibility factor, barometric distribution law.

Heat capacity of gases, real gases and virial expansions.

***Suggested Books*:**

- *Concise Inorganic Chemistry*, J. D. Lee, Fifth Edition, Blackwell Publishing, 2006.
- *Basic Inorganic Chemistry*, F. A. Cotton, G. Wilkinson, P. L. Gaus, 3rd Edition, John Wiley and Sons Press, 1995.
- Shriver and Atkins, *Inorgranic Chemistry*, 4th Edition Oxford University Press 2006.
- Atkins, P.W., de Paula, J., *Physical Chemistry*, 9th Edition Oxford University Press 2009.
- *Chemistry and Chemical Reactivity,* J. C. Kotz, P. M. Treichel, J. R. Townsend, 7th Edition, Brooks/Cole, Cengage Learning, Canada, 2010.
- *Chemistry*, R. Chang, 9th edition, McGraw-Hill, 2006.

**CHM 103: General Chemistry Laboratory (1 Credit)**

***Learning Objectives*:**

To learn practical experimental execution of basic chemical reactions including synthesis, purification, analysis, kinetics etc.

***Suggested Experiments:***

- Synthesis of cyclohexanone oxime
- Acetylation of salicylic acid
- Synthesis of polymer, Nylon 6-10
- Determination of strength of acid and base
- Estimation of acetic acid in vinegar solution
- Preparation of hexamine nickel chloride $[Ni(NH_3)_6]Cl_2$
- Detection of common cations and anions
- The clock reaction
- Thin Layer Chromatography
- Photochemical reduction of ferric oxalate

## CS 101: Introduction to Computers (3 Credits)

***Learning Objectives*:**

The aim of the course is to teach algorithmic problem solving and its actualization in a real programming language. The course has a lab component to give students hands-on experience with computers and programming.

***Course Contents*:**

- Data types, Variables, Identifiers
- Variable declaration, Assignment statement
- Input/Output, Comments
- Operators and Expressions
- Conditional expressions
- Conditional statements: if-then, if-then-else, nested conditionals, switch-case
- Loops: for, while, repeat
- Arrays, multi-dimensional arrays
- Functions
- Recursion
- Pointers
- Memory and its management
- Structures
- Data Structures

***Suggested Readings*:**

- Schaum's Outline of Programming with C by Byron Gottfried, McGraw-Hill India.
- Programming in ANSI C by Balaguruswamy.
- The C Programming Language by Kernighan and Ritchie, Prentice-Hall India.

**HSS 103: Basics of Communication Skills (1 Credit)**

*Communication Skills:* Process of Communication, Principles of Communication, Barriers to Communication, Ways to avoid barriers, Oral and Written Communication, Verbal and Nonverbal Communication

*Reading Skills:* Process of Reading, way to improve reading skills Reading Comprehension Skills: Discovering structure; identifying themes and sub-themes; understanding and interpreting facts; distinguishing facts from opinions and specific from general statements; searching for information; drawing information and making generalizations.

*Language Skills:*

a. Common Grammatical Mistakes: Sentence fragments, Comma splice, Run-together-fused sentences; Faulty agreement and reference of pronouns; Shifts in point of view; Mixed constructions; Omissions; Incomplete and illogical comparisons
b. Diction: Denotation and connotation; Exactness, appropriateness and effectiveness; Idiomatic usage; Colloquialisms
c. Strategies: Economy, emphasis, Clarity, concreteness, unity and coherence

*Spoken Language Skills*: Descriptive, narrative, argumentative and expository techniques in spoken language use

*Listening Skills:* Importance and Process of Listening, Types of Listening, Barriers to Listening

*Role Plays*

***Suggested Books*:**


- Andrea J. Rutherfoord, Basic Communication Skills for Technology, Pearson Education. Inc., Eleventh Edition, 2010
- Matthukutty M Monippally, Business Communication Strategies, Oxford University Press, Sixth Edition, 2011
- Meenakshi Raman & Sangeeta Sharma,Technical Communication, Oxford University Press, Sixth Edition, 2011

**MTH 101: Calculus of One Variable (3 Credits)**

***Learning Objectives*:**

This is a core mathematics course for first-semester BS-MS students. The course introduces the basic concepts of differential and integral calculus of one real variable with an emphasis on careful reasoning and understanding of the material.

***Course Contents*:**

Introduction to the real number system, field axioms, order axioms and the completeness axiom.

Sequences and series of numbers, convergence of a sequence, Cauchy's criterion, limit of a sequence, supremum and infimum, absolute and conditional convergence of an infinite series, tests of convergence, examples.

Limits and continuity, definitions, continuity and discontinuity of a function at a point, left and right continuity, examples of continuous and discontinuous functions, intermediate value theorem, boundedness of a continuous function on a closed interval, uniform continuity.

Differentiation, definition and basic properties, Rolle's theorem, mean value theorem, Leibnitz's theorem on successive differentiation, Taylor's theorem.

Integration, Riemann integral viewed as an area, partitions, upper and lower integrals, existence of the Riemann integral, basic properties, fundamental theorem of integral calculus, integration by parts, applications.

***Suggested Books*:**


- G. B. Thomas and R. L. Finney, *Calculus and Analytic Geometry*, 9th Edition, Indian student edition, Addison-Wesley, 1998
- T. M. Apostol, *Calculus,* Volumes 1 and 2, 2nd Edition, Wiley Eastern, 1980
- R. Courant, F. John, *Introduction to Calculus and Analysis,* Volume 1, Classics in Mathematics, Springer, 1989

**PHY 101: Mechanics (3 Credits)**

***Learning Objectives*:**

The course will introduce foundations of Newton's laws of mechanics and its application to many particle sytems, rotational motion, non-intertial systems. The course will also introduce the theory of special relativity.

***Course Contents*:**

*Kinematics:* Introduction to coordinate systems, polar coordinate system, velocity and acceleration in polar coordinate system.

*Kinetics:* Force, Newton's laws of motion, Frames of reference, Momentum, Momentum of system of particles, Conservation laws, Center of mass, Variable mass system, Collision in laboratory and Center of mass system and Scattering.

*Relativity:* Axioms of relativity, Lorentz transformation, length contraction, time dilation, relativistic mass energy, Doppler effect.

*Rigid body motion:* Rigid body, Moment of inertia, Rigid body kinematics, Rigid body kinetics, Motion of gyroscope.

*Non Inertial Frame:* Physics in the rotating coordinate system, Fictitious force.

*Central force and Motion of planets and satellites*

*Oscillations and Waves:* Small oscillations, damped harmonic oscillation and forced oscillation, Q factor and resonance. Differential equation of one dimensional wave and its solution, reflection and transmission of waves.

*Note: Mathematical tools may be introduced as and when required.*

***Suggested Books*:**

- D. Kleppner and R. Kolenkow, *An Introduction to Mechanics*.
- R. P. Feynman, R. B. Leighton and M. Sands, *The Feynman Lecture of Physics* Vol 1.
- C. Kittel, W. D. Knight, M. A. Ruderman, and A. C. Helmholz *Mechanics (Berkeley Physics course)* Vol 1.
- D. Resnick, R. Halliday and K. S. Krane, *Physics,* Vol 1, 5$^{th}$ Edition
- M. K. Verma, *Introduction to Mechanics*.

**PHY 103: General Physics Laboratory I (1 Credit)**

***Learning Objectives*:**

The laboratory course will provide hands on session on the experiments that involve understanding theoretical principles gathered by the student in PHY-101 course.

***Course Contents*:**

- Measurement of length and error analysis
- Gyroscope
- Determination of 'g' by bar pendulum
- Pohl's Pendulum
- Determination of 'g' by free fall
- Shear modulus using Tortional pendulum
- Mechanical hysteresis
- Young's modulus
- Moment of Inertia
- Velocity of sound using resonance tube
- Velocity of sound using Kundt's tube
- Spring constant