1. **Course Number and Title: ACC-105: English (Compulsory): One**
2. **Credit Hours: 4**
3. **Course Description**

This is an introductory general English course compulsory for all the students of the programme. The content of this course is designed to strengthen students' ability in all four basic language skills. Extra emphasis is given on developing students' grammatical competence and writing ability. Following this line, the course is organized on linguistic principles providing guidelines for solving language problems at under graduate level.

4. **Course objectives**

The objectives are to help learners to:

a. speak correct and appropriate English to perform various social functions; eg., using formulas, giving directions, presenting advantages/ disadvantages of a point clearly.
b. comprehend general meaning of lectures and classroom conversations.
c. participate in class discussions and present their point of view.
d. read books of moderate difficulties with comprehension following simple reading techniques like skimming and scanning.
e. use correct forms of simple and compound sentence patterns in writing simple compositions.

5. Course Content **Contact Hours**

Unit 1: Grammar Review **6**

Learning Outcomes

At the end of this unit learners will be able to-

a. form correct sentences of their own
b. convert sentences from one form to another
c. write sentences using different form of tenses

Content:

- Syntax-forms of sentences
- Conversion of sentences
  negative, question forms, question –tags, etc.
- Review of tenses-present, past and future
  (simple, continuous, perfect simple and continuous), Verb patterns
- Direct-indirect speech
- Common mistakes in English

Unit 2: Developing new vocabulary **6**

Learning Outcomes

At the end of this unit learners will be able to-

a. study and record vocabulary
b. form words
c. use words in context

Content

- Prefix, suffix; noun, verbs, and adjectives with the same forms, compound nouns and compound adjectives
- Collocations (word patterns), verb or adjective + preposition, preposition +noun

- Phrasal verbs, idioms and fixed expressions
- Make, do have, take, give, keep, break, catch, see
- Get: uses, and expressions; Go: uses and expressions
- Apologies, excuses, thanks
- Request, invitation, suggestions, opinions, agreeing, and disagreeing,
- Specific situations and special occasions
- Connecting and linking

Unit 3: Listening **3**

Learning Outcomes

At the end of this unit learners will be able to-

a. comprehend English speech spoken by native and nonnative speakers
b. respond appropriately after listening to spoken English
c. act accordingly after listening recorded speech

Content:

- Listening to authentic speech-comprehension
  (listening for headlines/topic sentences)
- Listening techniques, tasks and assessment criteria

Unit 4: Speaking **6**

Learning Outcomes

At the end of this unit learners will be able to-

a. make polite request and offers
b. accept and refuse invitation
c. participate in dialogues
d. take part in interview
e. make presentation

Content:

- Comprehending and using social English (use of formula)
- Making polite request and offers
- Asking questions in social situation
- Accepting and refusing an invitation
- Practising dialogues i.e. job interviews, telephone conversation, business dealings, ordinary food, booking tickets
- Practising presentation with appropriate language and technology

Unit 5: Reading **8**

Learning Outcomes

At the end of this unit learners will be able to-

a. read considerable complex text with ease
b. recite poems with correct stress and intonation
c. answer questions on the comprehension of the text

Content:

Reading Authentic Texts for Prose and Poetry

- A Passage to India part – 1
  E. M. Forster

- Poem: Gods-W. Whitman
- Adieu to a Soldier-W. Whitman
    i. Reading for details (bottom-up model)
    ii. Guessing meaning from context
    iii. Reading for comprehension of message
    iv. Reading for specific information
    v. Use of dictionary in reading.

Unit 6: Writing **5**

Learning Outcomes

At the end of this unit learners will be able to-

a. write composition in English following proper punctuation
b. write both formal and informal letters
c. prepare complete Resume / CV
d. write different types of paragraph and essays

Content:

- Writing paragraph: Steps of writing, topic sentences, supporting ideas, cohesion and coherence
- Describing charts and graphs using appropriate language and vocabulary
- Writing essays: Descriptive and narrative essays
- Writing formal and informal letters/emails: Job application letters, joining letter, reference letters, letter of motivation, thank you letters, complaint letter, appreciation letter, ordering letter
- Writing cover letter and resume looking at the requirements specified.
- Mechanics of writing: punctuations (comma, semicolon, colon, dash, hyphen, quotation marks, parenthesis, apostrophe, contractions), capitalization, spelling, grammar, paragraphing, omission of words, abbreviations, use of quotations,
- Writing academic and non-academic reports with references

Unit 7: Practicum **6**

Learning Outcomes

At the end of this unit learners will be able to-

a. practice listening and speaking in various social situations
b. describe events and situations

Content:

- Listening with comprehension
- Speaking using social language, asking questions and describing events
- Reading with comprehension

6. Instructional Strategy

a. Lecture
b. Question-Answer
c. Pair-work
d. Group Discussion
e. Individual Presentation
f. Watching audio-visual materials
g. Debate,

h. Project Method.
i. Role Playing etc.

8. Assessment

a. Two In-course examinations - 30 Marks
b. Semester final examination (MCQ + Essay) - 60 Marks
c. Assignment/Presentation - 10 Marks

9. Recommended Books, Journals and Reports

1. Hornby, A.S. (1992), Oxford Learner's Dictionary of Current English, Oxford University Press, London.
2. Leech, G., &Svartvik, J. (1975, Reprint 1993), A communicative grammar of English Longman Singapore Publishers (pte) Ltd.., Singapore.
3. Rahman, M.F. Kawser, M.A. (2007), My English Teacher, Supreme Publishers, Dhaka-1229
4. Soh, D. A. (1989), Writing by doing: learning to write effectively, 2nd Edition, NTC Publishing group: Illinois.
5. USA.
6. Swan, M. (1989), Basic English usage, ELBS/ (Oxford University Press.
7. Wren, P.C., & Martin, H. (1936, Reprinted 1995), High school English grammar and composition. S. Chand & Company Ltd., New Delhi, India
8. http://www.lrbusinessed.com/bcp/textbook_files/chapter05.pdf

Additional Books and Materials

1. Newspapers, Magazines. Journals, etc for authentic reading
2. A-V Equipments for listening and speaking practice.

1. **Course Number and Title: PC–112: Education in Bangladesh**

2. **Credit Hours: 4**

3. **Course Description**

   The course introduces the students to the national system of education: origin, components, types, policies, goals, constitutional, and legal provisions. It also introduces the students to the different sectors of education, i.e. pre-primary, primary, secondary, tertiary, technical and madrasa education, their origin, programs, objectives, structure, participation of students, curriculum and instructional activities, evaluation, planning, management and financing of the system. This course addresses SDG 4 to think about maintaining quality Education in different sectors of education in Bangladesh. It further focuses on the problems and issues of education in Bangladesh with their possible solutions.

4. **Course objectives**

   The objectives are to help learners to:

   a. acquaint with the concept, structure, goals, objectives, and issues of national system of education.
   b. gain a comprehensive view of pre-primary, primary, secondary and tertiary education – their present status, institutions, access and participation, curriculum, evaluation, organization, management, supervision and finance.
   c. gain insights into the concepts, goals, strategies, programs of the integrated non-formal and mass education.
   d. understand madrasa education as a parallel system of main stream education.
   e. understand the importance vocational and technical education system in the country.
   f. identify the major problems and obstacles of education and develop their insight into the causes of the problems and their possible solutions.
   g. know and understand Sustainable Development Goals, especially Sustainable Development Goal 4 and means of achieving the targets.

5. **Course Content** **Contact Hours**

Unit 1: Education as a National System-A phase of Transition **6**

Learning Outcomes

At the end of this unit learners will be able to-

a. describe brief history of education from aryan till today
b. explain relationship between goals & objectives of education and philosophy of education
c. explain origin and components of national system of education
d. demonstrate present structure of education system
e. describe legal frame work of education in Bangladesh
f. provide explanation of administrative structure of education system in Bangladesh
g. describe the goals of sustainable development in relation to education (SDG 4)

Content:

- Concept of a national system of education
- Historical development of education starting from Aryan-till to-day
- Origin, component, types of national system of education
- Goals, objectives, philosophy, policies, constitutional provision and legal frame work
- Structure of education
- Sustainable development goals (SDG 4)

Unit 2: Pre-Primary Education **4**

Leaning Outcomes

At the end of this unit learners will be able to-

a. describe present situation of pre-primary education in Bangladesh in relation to goal and objectives of pre-primary education
b. explain curriculum matrix of pre-primary education on the basis of learning areas
c. explain role of GO and NGO's to promote pre-primary education in Bangladesh
d. problems and issues of pre-primary education in Bangladesh with possible solutions

Content:

- Present structure, goals and objectives
- Accesses participation and transition
- Curriculum matrix: Learning areas, learning activity, learning outcomes
- Initiatives and concerned organizations: GO, NGO and INGOs
- Achievements and Challenges

Unit 3: Primary Education **7**

Leaning outcomes

At the end of this unit learners will be able to-

a. analyse present situation of Primary Education in relation to acts and regulations and innovations of Primary Education in Bangladesh
b. describe goal, objectives, components and background of Primary Education Development Programs (PEDP)
c. analyse the role of Ministry of Primary and Mass Education (MoPME) & Directorate of Primary Education (DPE) and line organizations in planning, management, and financing of Primary Education
d. identify problems and issues of primary education and suggest possible solutions to meet up the goals of sustainable development

Content:

- Present structure, goals and objectives
- Access, participation transition and equity
- Acts and regulations
- Curriculum, Textbooks, Teachers Guide, Question booklet assessment and role of NCTB
- Evaluation and examination system
- Innovations in primary education
- Ongoing projects and development programs
- Initiatives and concerned organizations / institutions: GO, NGO and INGOs
- Planning, management and financing of primary education: Role of Ministry of Primary and Mass Education (MoPME), Directorate of Primary Education (DPE) and Line organization
- Major issues and problems, possible solutions

Unit 4: Secondary Education **5**

Leaning Outcomes

At the end of this unit learners will be able to-

a. demonstrate present structure of secondary education
b. evaluate the present situation of Secondary Education in relation to acts and regulations and innovations of Secondary Education in Bangladesh

c. describe the role and responsibilities of Ministry of Secondary Education (MoE), and Directorate of Secondary and Higher Education and Line organization in planning, management, and financing of Secondary Education
d. mention the GO and NGO initiatives to improve the quality of secondary education
e. identify problems and issues of secondary education and find out the possible solutions to meet up the goals of sustainable development

Content:

- Present Structure, goals and objectives
- Access, participation, completion and equity
- Curriculum, Textbook, Teachers Guide, Assessment and role of NCTB
- Evaluation and examination system and the role of Education Boards
- Ongoing projects and Development programs
- Initiatives and concerned organizations / institutions: GO, NGO and INGOs
- Management, Planning & financing of Secondary education: role of Ministry of Education(MoE), Directorate of Secondary and Higher Education (DSHE) and Line organizations
- Challenges and possible solutions

Unit 5: Higher/Tertiary Education **4**

Leaning Outcomes

At the end of this unit learners will be able to-

a. explain with examples types of higher education institutions in Bangladesh and their features
b. evaluate the present situation of Higher Education in Bangladesh
c. evaluate/critique the role and responsibilities of University Grants Commission (UGC) in planning, management, and financing of Higher Education
d. identify problems and issues of higher education and find out the possible solutions to meet up the goals of sustainable development

Content:

- Goal and objectives
- Types: universities, colleges, specialized institutions
- Present structure, access and participation in Higher Education
- Management and financing
- Role of University Grants Commission (UGC)
- Ongoing projects and development programs
- Prospects, problems and solutions

Unit 6: Madrasha Education **4**

Leaning Outcomes

At the end of this unit learners will be able to-

a. describe origin and history and types of Madrasha education
b. present structure with innovations of Madrasha education in Bangladesh
c. describe the role and responsibilities of Ministry of Education (MoE), Directorate of Madrasha Education (DME), NCTB, Bangladesh Madrasha Education Board (BMEB) in management, and financing of Madrasha Education
d. evaluate the GoB and project initiatives to improve the quality of Madrasha education
e. identify problems and issues of Madrasha education and find out the possible solutions to meet up the goals of sustainable development

Content:

- Origin, concept and types of Madrasha education
- Present structure, goals, objectives, access and participation
- Innovations in Madrasha education
- Curriculum assessment and instructional processes
- Madrasha Education Board
- Management and financing
- Major issues and problems and their possible solutions

Unit 7: Technical and Vocational Education **4**

Leaning Outcomes

At the end of this unit learners will be able to-

a. demonstrate present structure of technical and vocational education
b. describe the role and responsibilities of the following organizations in planning, management, financing and quality improvement of technical and vocational education:
c. evaluate the role of technical and vocational education to economic development of Bangladesh
d. evaluate the programs and projects for TVET
e. identify problems and issues of technical and vocational education and find out the possible solutions to improve the quality
f. ministry of Education (MoE), and Directorate of Technical Education (DTE), Technical Education Board (TEB)

Content:

- Structure, goals and objectives
- Access and participation, Gender
- Curriculum, NQF
- TVET for employability and sustainable development
- Planning, management and financing
- Programs and Projects in technical and vocational education
- Technical Education Board
- Prospects, problems and solution

Unit 8: Teacher Education and Training in Bangladesh: Initial (pre-service), In-service and Continuous Professional Development **6**

Leaning Outcomes

At the end of this unit learners will be able to-

a. describe types and features of teacher education in Bangladesh
b. analyse functions of teacher training institutes (PTI, TTC, HSTTI, BMTTI, VTTI, TTC) for quality development of teachers in Bangladesh
c. identify problems and issues of teacher training institutes and find out the possible solutions to meet up the goals of sustainable development
d. evaluate teacher training institutes- achievements and challenges

Content:

- Primary Teacher Education: Primary Teacher Training Institute (PTI): Curriculum Assessment
- Sub-Cluster Training, Upazila Resource Centre (URC)
- NAEM, NCTB in Teacher Education
- Secondary Teacher Education: Public and Private, Programs, Curriculum, Evaluation, Problems

- Higher Secondary Teacher Training Institute (HSTTI) and its role
- Bangladesh Bureau of Educational Information and Statistics (BANBES)
- Bangladesh Madrasha Teachers Training Institute (BMTTI)
- Technical Teachers Training College (TTTC)
- Institute of Education and Research: Programs, Curriculum, Evaluation
- Prospects, Issues and Challenges

6. Instructional Strategies

a. Lecture
b. Guided discussion
c. Group work
d. Seminar
e. Case study
f. Project Work

7. Assessment

a. Two In-course Examinations	15 × 2 =	30
b. Course Final Examination (MCQ + Essay)	20 +40=	60
c. Assignment/Presentation		10

a.

8. Recommended Books, Journals and Reports

1. BANBEIS, (2016), *Educational Statistics*.
2. Bangladesh Bureau of Statistics (BAS): Statistical Yearbook of Bangladesh, Dhaka.
3. Govt. of the People's Republic of Bangladesh, Bangladesh Education Commission Reports 1973, 1988 and 2000 Dhaka.
4. Ministry of Education (1992), Secondary Education Sub-Sector Study, Dhaka.
5. Nurullah, S. & Naik, J.P. (1962), A Student's History of Education in India, Bombay, Mac Millan & Co.
6. আজহার আলী ও হোসনে আরা বেগম (১৯৯৩), *প্রাথমিক শিক্ষা*, বাংলা একাডেমী, ঢাকা।
7. আবুল মোমেন (১৯৯৭), *বাংলাদেশের মাদ্রাসা শিক্ষা*, বাংলাদেশ নারী প্রগতি সংঘ, ঢাকা।
8. আব্দুল মালেক ও অন্যান্য (২০০৭), *শিক্ষা বিজ্ঞান ও বাংলাদেশে শিক্ষা*, বাংলাদেশ বিশ্ববিদ্যালয় মঞ্জুরী কমিশন, ঢাকা।
9. কামরুন্নেসা বেগম ও সালমা আখতার (২০০০), *প্রাথমিক শিক্ষা বাংলাদেশ*, ঢাকা।
10. *'জাতীয় শিক্ষা সপ্তাহ'* পুস্তিকা, শিক্ষা মন্ত্রণালয়।
11. ড. শরিফা খাতুন, *মাধ্যমিক শিক্ষা*, বাংলা একাডেমী।
12. দেলোয়ার হোসেন শেখ (২০০৩), *শিক্ষা উন্নয়ন*, *উন্নয়নশীল দেশের প্রতিশ্রুতি*, হাক্কানী পাবলিশার্স, ঢাকা।
13. মো. ইলিয়াস আলী (১৯৯৯), *যুগে যুগে শিক্ষা কমিশন ও শিক্ষার উত্তরণ*, জাগরণী প্রকাশনী, ঢাকা।
14. *মাদ্রাসা শিক্ষা*, বাংলা একাডেমী, ঢাকা।
15. মুহাম্মদ আলী ও রওশন আরা বেগম (২০০০), *শিক্ষা প্রশাসন ও ব্যবস্থাপনা*, মাধ্যমিক শিক্ষা উন্নয়ন প্রকল্প, শিক্ষা মন্ত্রণালয়।
16. মু. শামস-উল-হক, (১৯৮৭), *বিকাশমান সমাজ ও শিক্ষা*, বাংলা একাডেমী, ঢাকা।
17. হোসনে আরা বেগম, *শিক্ষা প্রশাসন ও ব্যবস্থাপনা*।
18. হোসনে আরা বেগম ও মো. আবদুস সালাম (২০০২), *আনুষ্ঠানিক ও উপানুষ্ঠানিক শিক্ষা: বাংলাদেশ*, ঢাকা: মুক্তি প্রিন্টার্স, ।
19. রওশন আরা চৌধুরী (১৯৮৭), *প্রাথমিক শিক্ষা প্রশাসন*, ঢাকা, বাংলাদেশ।
20. শামস-উল-হক, (১৯৮৫), *উচ্চ শিক্ষা*, *বাংলাদেশ*, বাংলা একাডেমী, ঢাকা।
21. Related Reports, Journals and Websites.

1 Course Number and Title: ACS-312: Mathematics-Two: Differential and Integral Calculus

2 Credit Hours: 4

3 Course Description

This is a fundamental course on calculus dealing specifically with derivatives and integrals of algebraic and transcendental functions. Students will learn to use the techniques of differentiation and integration. This course is designed to prepare the learners for future mathematics courses in applying the knowledge acquired in different contexts. Emphasis is given on clarity of understanding and rigor in reasoning. Mathematical activities with software such as *GeoGebra* or *Mathematica or MathLab* are included as Math Lab Tasks which are designed for the purpose of continuous assessment. These tasks are expected to stimulate learning and deepen mathematical understanding.

4 Course objectives

The objectives are to help learners to:

a. define, explain, analyze and describe the basic concepts of derivatives and anti-derivatives.
b. apply the theorems, principles and methods for solution of theoretical as well as practical problems.
c. develop the skill to differentiate and integrate different types of functions.
d. acquaint with the skills to formulate and analyze mathematical models for a variety of real-world phenomenon.

5 Course Content **Contact Hours**

A. Theoretical

Unit 1: Limit and Continuity of Functions of Single and Several Variables 7

Learning Outcomes

At the end of this unit learners will be able to-

a. analyze functions graphically using the concept of limits
b. evaluate limits of single-variable and multi-variable functions graphically and algebraically
c. evaluate continuity of functions of single-variable and multi-variable graphically and algebraically

Content:

Functions of single variable

- Limit: Origin of Calculus, Concept of limits (Intuitive approach, Tabular & Algebraic Methods), One-sided & Two-sided Limits, Computing Limits of several functions (Polynomial functions, Rational functions, Functions involving Radicals, Piece-wise defined functions, Hyperbolic functions), Limits at infinity & Infinite Limits, Asymptotes,
- Continuity: Introduction to Continuity, Continuity at a point, Continuity on (Open & Closed) Intervals and their Graphical Representation, Computing Continuity of several functions (Polynomial functions, Rational functions, Composite functions, Inverse functions, Trigonometric functions, Hyperbolic functions), Intermediate value theorem and its application, Squeezing theorem and its application

Functions of Several Variables

- Limit: Concepts of limits for function of several variables, computing limit of functions of several variables.
- Continuity: Concepts of continuity for function of several variables, determining continuity and discontinuity of functions of several variables.

Unit 2: Derivative **6**

Learning Outcomes

At the end of this unit learners will be able to-

a. explain the basic concept of derivatives
b. illustrate the relationship between differentiability and continuity
c. compute derivatives of different types of functions
d. explicate chain rule, implicit differentiation and parametric differentiation
e. apply derivatives in real life situation

Content:

- Basic concepts of tangent lines, average velocity, instantaneous velocity and rate of change
- Definition of derivatives with geometrical interpretation
- Differentiability at a point and on (open & closed) intervals
- Relationship between differentiability and continuity
- Computing derivatives of several functions (Constant function, polynomial functions, rational function, piecewise-defined functions, trigonometric functions, hyperbolic functions) using both definition of derivatives and derivative formulas
- Chain rule, implicit differentiation, and parametric differentiation
- Derivatives in real life problems

Unit 3: Successive Differentiation **3**

Learning Outcomes

At the end of this unit learners will be able to-

a. state the concepts of higher order derivatives
b. derive Leibnitz's Theorem with its application

Content:

- Concepts of higher order derivatives
- Leibnitz's Theorem and its applications

Unit 4: Partial Derivatives **3**

Learning Outcomes

At the end of this unit learners will be able to-

a. interpret the partial derivatives and higher order partial derivatives
b. analyze chain rule for two and three variables, including construction of their tree diagrams
c. compute partial derivatives of functions of several variables

Content:

- Concepts of partial derivatives with graphical representation
- Computation of partial derivatives of functions of two and more than two variables

- Higher order partial derivatives
- Chain rule (two and three variables)

Unit 5: Definite and Indefinite Integrals **7**

Learning Outcomes

At the end of this unit learners will be able to-

a. explain the concept of integration aligned with the area problem
b. perform integration using elementary integration formulae
c. solve integration by different techniques
d. analyze and use the Fundamental Theorem of Calculus

Content:

- Area problem and basic concepts of integration
- Elementary integration formulae
- Methods of integration (Integration by Parts and Method of Substitution)
- Trigonometric integrals, trigonometric substitutions
- Integrating rational function
- Fundamental Theorem of Calculus

Unit 6: Improper Integrals **3**

Learning Outcomes

At the end of this unit learners will be able to-

a. state the basic properties of improper integrals
b. calculate different forms of improper integrals

Content:

- Properties of improper integrals
- Computations of improper integrals

Unit 7: Multiple Integrals **3**

Learning Outcomes

At the end of this unit learners will be able to-

a. describe the basic concepts of double integrals over rectangular, non-rectangular region and polar coordinate system
b. calculate double integrals over rectangular and non-rectangular region

Content:

- Double integrals over rectangular regions, non-rectangular regions and their applications

B. Practical

Math Lab Tasks **8**

After completing the *Math Lab Tasks (*using *GeoGebra/Mathematica/MathLab software)* the learners will be able to:

a. examine limit, continuity/discontinuity of functions single-variable and function of several variables
b. plot graphical representation of partial derivatives
c. calculate the area under curve using integration and draw the region

6 Instructional Strategies

a. Lecture and classroom interaction
b. Group study and discussion
c. Individual/pair/group presentation
d. Problem Solving Activities
e. Practice of Mathematical Software(s)

7 Assessment

a. Two Incourse Examinations
b. Semester Final Examination
c. Math Lab Tasks as Assignment

8 Recommended Books, Journals and Reports

1. Anton, H., Biven, I. and Davis, S. (2005). *Calculus (8th Edition)*. USA, John Wiley and Sons Inc.
2. Courant, R., McShane, E. J. (1988). *Differential and Integral Calculus*. V. 1(2nd Edition). Boston: John Wiley & Sons.
3. Hoffmann & Brandley (2004). *Calculus For Business, Economics, and the Social and Life Sciences*, (8th Edition). New York: McGraw Hill Higher Education.
4. Smith, R. T. and Minton R. B. (2005), *Calculus.* (2nd International Edition). New York: McGraw Hill Higher Education.

1. **Course Number & Title: ACS-322: Physics-Two: Heat, Thermodynamics and Optics**
2. **Credit Hours: 4**
3. **Course Description**

The course is intended students to clarify the concepts on Heat, Thermodynamics and Optics. It will also help students to identify the applications or relate the above science concepts with the nature and/or natural phenomenon. Finally, the laboratory work on the related concepts will guide students to clarify their learning and also increase their interest to know and apply science concepts in exploring and explaining the natural world in their surroundings.

4. Course objectives

The objectives are to help learners to:

- acquire knowledge and skills about the concept of heat thermodynamics and optics.
- develop attitude to apply and analyse real life phenomena with the help of the concept of heat, thermodynamics and optics.

5. Course Content **Contact Hours**

Unit 1: The Zeroth Law of Thermodynamics **6**

Learning Outcomes

At the end of the unit learners will be able to-

a. explain microscopic and macroscopic descriptions of a thermodynamic system and its environment
b. explain the zeroth law of thermodynamics
c. correlate different temperature scales

Content:

- Thermodynamic system and its environment
- Microscopic and macroscopic description of a system
- Thermodynamics and statistical mechanics
- Temperature and the zeroth law of thermodynamics
- Measuring temperature
- Relation among temperature scales
- Expansion of solids

Unit 2: Heat and First Law of Thermodynamics **4**

Learning Outcomes

At the end of the unit learners will be able to-

a. explain first law of thermodynamics
b. apply first law of thermodynamics in real life situation

Content:

- Heat and first law of thermodynamics
- Heat a form of energy
- Heat and work
- Application of first law of thermodynamics

Unit 3: Kinetic Theory of gases **3**

Learning Outcomes

At the end of the unit learners will be able to-

a. interpret pressure, temperature and internal energy in terms of kinetic theory of gases
b. apply the idea of degrees of freedom and equipartition of energy to calculate molar heat capacities
c. interpret distribution of molecular speeds using graphical representation
d. develop an attitude towards relating the concept of kinetic theory with the natural phenomenon

Content:

- Macroscopic and microscopicdescription of ideal gas
- Representation of states of ideal gas on PV diagrams
- Kinetic interpretation of pressure and temperature
- Specific heats of ideal gas
- Degrees of freedom and equipartition of energy
- Mean free path
- Distribution of molecular speeds
- Brownian motion

Unit 4: Second and Third Law of Thermodynamics **3**

Learning Outcomes

At the end of the unit learners will be able to-

a. explainthe occurrence of natural phenomena in terms ofthe second law of thermodynamics
b. apply concept of Carnot's cycle to understand energy conversion process in heat engine
c. identify entropy as a state variable of a thermodynamical system
d. relate entropy change in reversible and irreversible process with the cyclic function of heat engine
e. explain disorder in nature in terms of entropy

Content:

- The Second law of thermodynamics
- The Carnot' cycle
- The efficiency of engines
- Entropy of reversible and irreversible process
- Entropy and the second law
- Third law of thermodynamics

Unit 5: Interference of light **4**

Learning Outcomes

At the end of the unit learners will be able to-

a. identify the limitations of corpuscular theory to explain interference of light
b. explain interference and interference related natural phenomena
c. interpret intensity distribution in Young's experiment
d. calculate change of phase of light wave due to reflection
e. analyze interference in thin films and Newton's rings

Content:

- Light as a wave
- Interference
- Conditions of interference
- Young's experiment
- Intensity distribution
- Change of phase due to reflection
- Interference in thin films
- Newton's rings

Unit 6: Diffraction of light **4**

Learning Outcomes

At the end of the unit learners will be able to-

a. explain the concept of the diffraction of light
b. calculate the intensity distribution due to single and double slit Fraunhoferdiffraction
c. apply the concept of dispersive and resolving power of a grating in real life phenomenon

Content:

- Diffraction of light and its classifications
- Single slit diffraction
- Fraunhofer diffraction at double slit
- Multiple slit diffraction and grating
- Dispersive and resolving power of a grating

Unit 7: Polarization of light **3**

Learning Outcomes

At the end of the unit learners will be able to-

a. identify polarized and non-polarized lightin graphs and figures
b. express various polarized states of light mathematically
c. design experiment to produce polarized light
d. relate the concept of plane, circular and elliptically polarized light with natural phenomenon
e. apply the concept of optical activity in explaining the optical properties of materials

Content:

- Polarization of light
- Production of polarized light
- Plane, circular and elliptically polarized light
- Optical activity

Unit 8: Laser **3**

Learning Outcomes

At the end of the unit learners will be able to-

a. explain basic principles of laser
b. explain the working principle of and properties of Helium-Neon laser
c. evaluate the scope of applications of laser in science and real life

Content:

- Properties of laser beam
- Basic principles of laser
- Absorption, spontaneous and stimulated emission
- Population inversion
- Helium-Neon laser
- Application of laser

Laboratory Work: Students will perform at least five experiments from the following list **Contact Hours: 10**

a. Determination of the specific heat of a liquid by the method of cooling
b. Determination of the thermal conductivity of a bad conductor by Lee and Chorlton's method
c. Determination of the specific heat of a solid by the method of mixture with radiation correction
d. Determination of the value of J, mechanical equivalent of heat by electrical method
e. Determination of the refractive index of a liquid by plane mirror and pin method using a convex lens
f. Determination of the refractive index of the material of a convex lens by a telescope and spherometer
g. Determination of the angle of a prism, and the refractive index of the material of a prism
h. Determination of the radius of curvature of a lens by Newton's ring
i. Determination of the wavelength of monochromic light by Newton's ring
j. Determination of optical activity of sugar solution by means of polarimeter

6. Instructional Strategies

a. Lecture
b. Question-answer
c. Guided discussion
d. Group works
e. Investigation
f. Assignment

7. Assignment:

a. Students will be given home/class assignment which they will be required to submit on due date individually or in group

8. Assessment

a.	One In-course Examination	15× 1 =	15
b.	Semester Final Examination (MCQ + Essay)	20+40 =	60
c.	Practical Examinaiton		25

9. Recommended Books, Journals and Reports

1. Beiser, A., Mahajan, S., &Choudhury, S. R. (2011).*Concepts of Modern Physics (*6th ed.*).* New Delhi: Tata McGraw Hill Education Pvt. Ltd.
2. Besier, A. (2003).*Perspectives of Modern Physics* (5thed.). New York: McGraw-Hill, Inc.
3. Freedman, Y. (1996).*University Physics (*9thed.*).*Wisely Series Publishing Company.

4. French, A. P., *Vibration and Oscillatio*n. The M.I.T. Introductory Physics Series, W. W. Norton and Company, New York.
5. Giasuddin, A., &Shahabuddin, M. *Practical Physics (2nd ed.).* Hafiz Book House, Dhaka.
6. Ghatak, A. *Optics(3rd ed.).* New Delhi: Tata McGraw-Hill Publishing Company Ltd, India.
7. Halliday, D., Resnick, R., & Walker, J. (2008). *Fundamentals of Physics(*8th ed.*).* New Delhi: John Wiley and Sons (Asia) Ptd. Ltd.
8. Hecht, E., &Gansen, A. R. (2008).*Optics (4th ed.).* USA: Pearson Education Inc.
9. Jencins, A. J., & White, H. E. (2001).*Fundamentals of Optics (4th ed.)*. USA: McGraw-Hill Inc.
10. Jones, A. Z. (2008). *About.com: Physics*. Retrieved on July 7, 2008 from http://physics:about.com/.
11. Nave, C. R (2005).*Hyperphysics.*Georgia State University. Retrieved on July 7, 2008 from http://hyperphysics.phy-astr.asu.edu/hbase/hframe.html/
12. Raymond, S. (1986). *Physics for the Scientists and Engineers with Modern Physics(2nd ed.).*Saunders Golden Sunburst Series.
13. Resnick, R. &Halliday, D. *Physics Part-I*. New York: John Wiley & Sons, Inc.
14. Resnick, R. &Halliday, D. *Physics Part-II*. New York: John Wiley & Sons, Inc.
15. Subrarnanyam, N., BrijLal (2001). *A Textbook of Heat and Thermodynamics.*New Delhi:S Chand and Company (Pvt.) Ltd.
16. Worsnop, B. L., & Flint, W. *Advanced Practical Physics(2nd ed.).* London*:* Methuen & Company Ltd.
17. Zemansky, M. W., &Dittman, R., H. *Heat and Thermodynamics*. USA: McGraw-Hill Inc.

1. **Course Number and Title: ACS-332: Chemistry-Two: Organic Chemistry**
2. **Credit Hours: 4**
3. **Course Description**
   This course will acquaint pupil with different terms, facts, concepts, principles, laws and theirapplication. It includes bonding and structures, preparation, properties and. uses of organic compounds such as aliphatic hydrocarbons, aromatic compounds, alcohol and phenols, alkyl andaryl halides, aldehydes and ketones, carboxylic acids and their derivatives.

4. **Course objectives**
   The objectives are to help learners to:
   a. know the meaning of terms, specific facts and concepts of organic chemistry.
   b. know the preparation, properties and uses of different organic compounds.
   c. apply concepts and principles of organic chemistry to new situations.
   d. demonstrate skills and abilities needed to conduct experiments on organicchemistry prescribed in the syllabus.

5. **Course Content** **Contact Hours**

Unit 1 : Atomic Structure and Bonding **3**

Learning Outcomes

At the end of this unit learners will be able to-

a. explain the structural and bonding phenomena of organic compounds
b. sketch out different features of different orbitals and their hybridization
c. discuss the nature of bond lengths, bond angles, bond energies and polarity of bond
d. explain the basic mechanisms of reactions of organic compounds

Content:

- Bonding and structure in organic compounds, Orbitals and their hybridization, Shapes of, molecules, Polarity of bond. Bond lengths, bond angles and bond energies, Fundamentals of organic reactions and their mechanism

Unit 2: Aliphatic Hydrocarbons **12**

Learning Outcomes

At the end of this unit learners will be able to-

a. explain the phenomena of saturated and unsaturated hydrocarbons (Alkane, Alkene, Alkyne) in contrast to their nature, structure, features, uses etc
b. differentiate among and between different types of hydrocarbons in many aspects
c. value the resource of natural gas in Bangladesh
d. illustrate different reactions and describe their mechanisms in Aliphatic hydrocarbons

Content:

(a) Saturated hydrocarbons: Alkanes

Structure, nomenclature, preparation, properties and uses, Reactions, Mechanism of halogenations reaction.Petroleum refining, Petro-chemicals.Natural gas in Bangladesh, composition, refining, uses, CNG

(b) **Unsaturated hydrocarbons**

(i) **Alkenes**

Orbital picture of double bond, Nomenclature, Preparation, Properties and uses. Electrophilic addition reactions and their mechanism, Geometric isomerism

(ii) **Alkynes**

Orbital picture of triple bond, Nomenclature, preparation, properties and uses, oxyacetyleneflame

Unit 3: Aromatic Hydrocarbons **5**

Learning Outcomes

At the end of this unit learners will be able to-

a. explain the general features and properties of Aromatic hydrocarbons
b. illustrate different reactions and describe their mechanisms in Aromatic hydrocarbons

Content:

- Aromaticity and delocalization in benzenes, pyrroles, furan and thiophen. Sources of benzene and other aromatic compounds. Electrophilic substitution in aromatic compounds: nitration, sulphonation, halogenation, alkylation and acylation

Unit 4: Halogen Derivatives of Alkane and Benzene **4**

Learning Outcomes

After completion of this unit, students will be able to

a. Discuss the properties, uses and methods of preparations of Halogen derivatives of alkane and benzene
b. Illustrate different reactions and describe their mechanisms in Halogen derivatives of alkane and benzene

Content:

- Nomenclature, General methods of preparations, Properties and Uses.Nucleophilic Substitution and Elimination reaction

Unit 5: Alcohols and Ethers **4**

Learning Outcomes

At the end of this unit learners will be able to-

a. explain the properties, uses and sources of Alcohols and ethers
b. compare between industrial and laboratory preparations of Alcohols and Ethers

Content:

- Sources, Nomenclature, Industrial and Laboratory Preparations, Properties and Uses

Unit 6: Aldehydes and Ketones **6**

Learning Outcomes

At the end of this unit learners will be able to-

a. discuss the properties, uses and methods of preparations of Halogen derivatives of Aldehydes and Ketones
b. differentiate between aldehydes and ketones in contrast to their nomenclature, preparations, uses etc

Content:

- Nomenclature, Carbonyl group, General methods of Preparations, Properties and Uses

Unit 7: Carboxylic Acids and their Derivatives **3**

Learning Outcomes

At the end of this unit learners will be able to-

a. explain the nomenclature, properties and uses of carboxylic acids and their derivatives
b. describe the preparation methods of carboxylic acids and their derivatives

Content:

- Nomenclature, Preparations, Properties and Uses of carboxylic acids and their derivatives

Unit 8: Study of Some Aromatic Compounds **3**

Learning Outcomes:

At the end of this unit learners will be able to-

a. explain the fundamental features of different Aromatic compounds (Phenols. alkyl derivatives of benzene, Aniline, Diazonium salts, Azo dye)
b. describe the uses of Azo dye in textile industry

Content:

- Phenols alkyl derivatives of benzene, Nitro benzene, Aniline, Diazonium salts, Azo dye, Uses of azo dye in Textile industry

Practical:

Learning outcome

At the end of this unit learners will be able to-

a. apply concepts, principles and laws of Organic Chemistry in identifying organic compounds and their functional groups
b. demonstrate science process skills in conducting experiments in Chemistry
c. value empirical evidence in generating and supporting Chemistry concepts
d. value science process and demonstrate inquisitiveness, open-mindedness, skepticism and intellectual honesty

Content:

(i) Simple Laboratory techniques:

- Determination of melting points and rnixed melting points
- Purification of organic compounds by recrystallisation
- Determination of boiling point
- Purification by distillation

(ii) Identification of simple organic compounds containing one functional group out of thefollowing compounds:

- I-Butanol, 2-butanol, 2-methyl-2-propanol, phenol, propanone, acetophenone, benzophenone, methanal, ethanal, benzaldehyde, methanoic acid, ethanoic acid, benozoicacid, phenylamine, phenyl methyl amine, diphenyl amine, nitrobenzene, dichlorobenzene,urea and naphthalene

Tests for Identification of Organic Compounds

- detection of elements (N,S and halogen) in organic compounds
- solubility test with water, 5%aqueous sodium hydrogen carbonate, sodium hydroxide,hydrochloric acid, conc. sulfuric acid
- detection of functional groups
- specific test (if any)

6. Instructional Strategies

a. Lecture
b. Discussion
c. Group work
d. Problem solving
e. Project work.

7. Assessment

a. In-course examination	15 Marks
b. Semester final examination	60 Marks
c. Practical Examination	25 Marks

8. Recommended Books, Journals and Reports

1. Ahmad,W., &Joshi,H.C. (2017). *A Simplified Text Book of Organic Chemistry*. Lambert.
2. Bahl,A., &Bahl,B.S. (2010). *Advanced Organic Chemistry*. New Delhi,India: S.Chand& Co. Ltd.
3. Bruice,P.Y. (2016). *Organic Chemistry* (8th ed.). London: Pearson.
4. Clayden,J., Greeves,N., &Warren,S. (2012). *Organic Chemistry* (2nd ed.). Oxford,UK: Oxford University Press.
5. Housecroft,C.E., &Constable,E.C. (2010*). Chemistry: An Introduction to Organic, inorganic and Physical Chemistry*(4th ed.). upper Saddle River,NJ: Prentice Hall.
6. Klein,D. (2016). *Organic Chemistry: As A Second Language.* (4th ed.). Hoboken,NJ: Wiley.
7. Morrison,R.T., &Boyd,R.N. (1992). *Organic Chemistry* (6th ed.). Upper Saddle River,NJ: Prentice Hall.
8. Smith,M.B., &March,J. (2006). *March's Advanced Organic Chemistry: Reactions, Mechanisms and Structure*. Hoboken,NJ: Wiley.
9. Solomons,T.W.G., Fryhle,C.B., &Snyder,S.A. (2016). *Organic Chemistry* (12th ed.). Hoboken,NJ: Wiley
10. Wade, L.G., &Simek,J.W. (2016). *Organic Chemistry* (9th ed.). London: Pearson.

1. **Course Number and Title: ACS-342: Botany-Two: Phycology, Limnology, Lichens, Cryptogams, Gymnosperms and Plant Anatomy**
2. **Credit Hours: 4**
3. **Course Description**

   This course is designed to introduce learners with the basic knowledge of Phycology, Limnology, Lichens, Cryptogams, Gymnosperms and Anatomy. The students will develop skills for studying different plant specimens in the laboratory and in the field related to the pre-mentioned topics. It is expected that students will develop scientific attitude for studying plants as an important part of their life.

4. **Course objectives**

   The objectives are to help learners to:

   a. acquire basic knowledge of Phycology, Limnology, Lichens, Cryptogams, Gymnosperms and Plant Anatomy.
   b. develop skills for studying Phycology, Limnology, Lichens, Cryptogams, Gymnosperms and Plant Anatomy in the laboratory and in the field.
   c. develop positive attitudes and modern, scientific and applicable methods for studying plants.

5. **Course Content** **Contact Hours**

A. Theory

Unit 1: Phycology **5**

Learning Outcomes

At the end of this unit learners will be able to-

a. recognize major groups of algal genera based on classification
b. explain biological importance of Phytoplankton
c. explain the role of algae in different aspects

Content:

- Classification of Algae based on pigments, stored products, chloroplasts and flagella (According to Lee,1999)
- Life history, general characteristics, ecology and economic importance of major algal groups-Cyanophyta, Cholorophyta, Rhodophyta, Euglenophyta, Phaeophyta and Bacillariophyta
- Fresh water and marine phytoplankton with their biological importance
- Importance of algae as-
  a. primary food producer
  b. producer of water bloom
  c. indicator of water condition
  d. source of food, medicine, fodder
  e. other economic and industrial products

Unit 2: Limnology **6**

Learning Outcomes

At the end of this unit learners will be able to-

a. explain different types of aquatic environment
b. comprehend the origin and classification of lakes
c. describe water pollution with consequences

Content:

- Definition, scope and importance of Limnology
- Types of aquatic habitat
- Origin and classification of lakes on the basis of basin-shape and productivity
- Water pollution-Definition, causes, consequences and solution

Unit 3: Lichens **3**

Learning Outcomes

At the end of this unit learners will be able to-

a. explain general characteristics, classification and economic importance of Lichen

Content:

- General characteristics of lichen
- Classification of Lichen based on different criteria
- Economic importance of lichen

Unit 4: Cryptogams and Gymnosperms **8**

Learning Outcomes

At the end of this unit learners will be able to-

a. explain characteristics of Bryophyta, Pteridophyta and Gymnosperms
b. recognize the representatives of Bryophytic, Pteridophytic and Gymnospermic genera
c. describe economic importance of Bryophyta, Pteridophyta and Gymnosperm

Content:

- Characteristics and phylogeny of Bryophyta, Pteridophyta and Gymnosperm
- Characteristics, distribution and life history of *Riccia, Marchantia* and *Anthoceros*
- Study the life history of *Psilotum*, *Selaginella*, *Lycopodium*, *Equisetum* and *Sphagnum*
- Characteristics, distribution and life history of *Cycus*, *Pinus* and *Gnetum*
- Economic importance of Bryophyta, Pteridophyta and Gymnosperm

Unit 5: Plant Anatomy **5**

Learning Outcomes

At the end of this unit learners will be able to-

a. describe tissue and tissue system
b. explain secondary growth of root, stem and their transition
c. recognize anatomical features of common wood plants

Content:

- Tissue and tissue system.
- Secondary growth in stems and roots of selected plants: Jute, *Boerhaavia* and Chickpea
- Root-stem transition
- Internal structure and use of wood with reference to *Tectona grandis*, *Shorea robusta* and *Heritiera fomes*

B. Practical

Learning Outcomes **9**

At the end of this unit learners will be able to-

a. identify and recognize various types of algae, lichens, cryptogams and gymnosperms
b. measure different physical and chemical factors of water in the laboratory and in the field
c. identify and recognize various types of anatomical features of plant

Content:

Phycology, Limonology and Lichens

a. Study representative major Algal groups of different ecological habitats (acquatic, terrestrial, subaerial, marine, brackish and fresh water)
b. Study of the chemical and physical factors of water in the laboratory and in the field: temperature, turbidity, water colour, dissolved O_2, dissolved CO_2, temperature, water current and movement
c. Study of some common lichens available in Bangladesh

Higher Cryptogams and Gymnosperms

a. Study of external and internal morphology of cryptogams covered in the theory
b. Study of external and internal morphology of gymnosperm covered in the theory

Anatomy

a. Study of primary growth: transverse section of dicot and monocot stem
b. Study of secondary growth: Jute, *Boerhaavia* and Cheikpea
c. Transverse, tangential and radial section of *Tectona grandis*, *Shorea robusta* and *Heritiera fomes*

6. Instructional Strategies

a. Lecture
b. Group discussion
c. Demonstration
d. Inquiry
e. Field trip

7. Assessment

a. One incourse examinations	- 15 Marks
b. Semester final examination (MCQ + Essay)	- 60 Marks
c. Practical examination	- 25 Marks

8. Recommended Books, Journals and Reports

1. Bold, H.C. & Wynee M.J.(1978). *Introduction of the Algae*. Prentice-Hall, New Jersey, USA.
2. Arthur, J. E. & MacDaniels L. H. (1947). *An Introduction to Plant Anatomy*. McGraw-Hill Book Company Ltd, Inc. New York, London.
3. Lee, R.R. (1999). *Phycology*. Cambridge Univ. Press.
4. Smith G. M.(1971). *Cryptogamic Botany*, Vol.1. McGraw-Hill Book Company Ltd, Inc. New York, London.
5. Pandey B.P. (1989). –*Plant Anatomy*. S. Chand and Company Ltd. New Delhi.
6. Smith G. M. (1955). *Cryptogamic Botany*, Vol.I1. McGraw-Hill Book Company Ltd, Inc. New York, London.
7. খান, মাহবুবার রহমান; মো: আবুল হাসান (১৯৮৯)। *উদ্ভিদবিজ্ঞান*, প্রথম খণ্ড। হাসান প্রিন্টিং প্রেস, ঢাকা,
8. খন্দকার, মনিরুজ্জামান (১৯৯৮)। *লিমনোলজি* । ঢাকা বিশ্ববিদ্যালয়, ঢাকা।
9. খান, আমজাত আলী; ইসলাম,তরিকুল (১৯৯৭)। *উদ্ভিদবিজ্ঞান*, প্রথম খণ্ড।বাংলা বাজার, ঢাকা।
10. মিত্র, দেবব্রত; গুহ, জীবেশ; চৌধুরী, সলিল কুমার (১৯৯৩)। *উদ্ভিদবিজ্ঞান*, প্রথম খণ্ড। মৌলিক লাইব্রেরী, কলিকাতা।

1. **Course Number & Title: ACS-352: Zoology- Two: Comparative Anatomy and Physiology of Vertebrates**
2. **Course Hours: 4**
3. **Course Description**

Students will explore the relationships between animal structures and their functions, and investigate the physiological processes that enable animals to adjust to environmental changes. This course will introduce learners with anatomical peculiarities in different animals sequentially.

4. **Course objectives**

The objectives are to help learners to:

a. acquire fundamental knowledge of animal structures and functions.
b. develop skills for studying physiological processes for environmental adaptation.
c. develop scientific attitude toward conservation of animal.

5. **Course Content** **Contact Hours**

A. Theoretical

Unit 1: Anatomical diversity among vertebrates and physiology of digestion and respiration **18**

Learning Outcomes

At the end of the unit learners will be able to-

a. compare and contrast several structures of integumentary, skeletal system among vertebrates
b. describe structure of digestive and respiratory system among vertebrates
c. explain mechanism of digestion and respiration among ventebrates

Content:

- Integumentary system: Definition, structure and comparative anatomy of integument proper in different vertebrate groups; integumentary derivatives-glands, scales, feathers, hairs, beaks, claws, nails, hoofs, horns and antlers
- Skeletal system: Endoskeleton, axial and appendicular skeletons; Function of skeletal system
- Digestive system and physiology of digestion: General structure and modification of alimentary canal in different vertebrate groups; associated glands in the digestive system; mechanism of digestion
- Respiratory system and physiology of respiration: Respiratory system and accessory respiratory organs of vertebrates; mechanism of breathing among vertebrates

Unit 2: **Comparative Vertebrate Physiology** **12**

Learning Outcomes

At the end of the unit learners will be able to-

a. describe structure of excretory, circulatory, reproductive, nervous system among vertebrates
b. explain mechanism of excretion, circulation and reproduction among vertebrates
c. describe types and function of hormones

Content:

- Excretory system and physiology of excretion: Pro, meso and meta nephric kidneys; succession of kidney; Mechanism of exerction among vertabrates

- Circulatory system and physiology of circulation: Modification of aortic arches among vertebrates; Mechanism of circulation
- Reproductive system and physiology of reproduction: Reproductive system and accessory glands; Mechanism of reproduction among vertebrates
- Nervous system: Brain, spinal cord and cranial nerves of vertebrates
- Hormones: Types and functions

B. Practical **10**

Learning Outcomes

At the end of the unit learners will be able to-

a. dissect and identify different systems of vertebrates

Content:

- Dissection: Dissection and display of the digestive, circulatory, respiratory, nervous and reproductive systems of Lata (snake head) fish

6. Instructional Strategies

a. Lecture
b. Discussion
c. Group work
d. Demonstration

7. Assessment

a.	One In-course Examination	15× 1 =	15
b.	Semester Final Examination (MCQ + Essay)	20+40 =	60
c.	Practical Examination		25

8. Recommended Books, Journals and Reports

1. Coleman, J. Goin & Olive, B. Goin, (1970). *Comparative Vertebrate Anatomy*. New York: Barnes & Noble Inc.
2. Kent, George C. (George Cantine) & Carr, Robert K (2001). *Comparative anatomy of the vertebrates*. Dubuque, Iowa: McGraw Hill.
3. Kotpal.R.L (2004). *Modern Textbook of Zoology Vertebrates*. Meerut, India: Rastogi Publication.
4. Miller, S. A. & Harley, J. P. (1996). *Zoology*. USA: Wm. C. Brown Publishers.
5. Parker, T. J. &Haswell, W. A. (1959). *A Textbook of Zoology*. London: Macmillan & Co.
6. Romer, A. S. (1965). *The Vertebrate Body*. London: W.B. Saunders.
7. Storer, T. I., Usinger, R. L., Stebbins, R.C. &Nybakken, J. W. (2001). *General Zoology*. New Delhi, India: Tata McGraw-Hill Co. Ltd.
8. Weichert, C.K. (1970). *Anatomy of Chordates*. London. McGraw Hill Co.
9. Verma, P. S. (2000). *A Manual of practical Zoology Chordates*. New Delhi, India: S. Chand & Company Ltd.
10. Young J.Z. (2004). *The Life of Vertebrates*. 3rd Edition. Oxford University Press.