

**H.P. University, Summerhill, Shimla**

**Structure and Syllabus**

**of**

**ZOOLOGY**

**for**

**B.Sc. Undergraduate Programme**

**Based on:**

**U.G.C. Choice Based Credit System**

**(CBCS) Annual Pattern UG Courses**

**Model Curriculum**

**(Effective from Academic Session July, 2018 onwards)**

## Details of Courses for B.Sc. (Pass Course) Zoology Undergraduate Program

### Annual Pattern

Course	*Credits	
	Theory+ Practical	Theory+Tutorials
<p><b>I. Discipline Specific Courses</b> (12 Papers)</p> <p>04 Courses from each of the 03 disciplines of choice</p>	12X4= 48	12X5=60
<p><b>Discipline Specific Courses Practical / Tutorial*</b> (12 Practical/ Tutorials*)</p> <p>04 Courses from each of the 03 Disciplines of choice</p>	12X2=24	12X1=12
<p><b><u>II. Discipline Specific Elective Course</u></b> (6 Papers)</p> <p>Two papers from each discipline of choice including paper of interdisciplinary nature.</p>	6x4=24	6X5=30
<p><b><u>Discipline Specific Elective Course Practical / Tutorials*</u></b> (6 Practical / Tutorials*)</p> <p>Two Papers from each discipline of choice including paper of interdisciplinary nature</p>	6 X 2=12	6X1=6

### III. Ability Enhancement Courses

- 1. Ability Enhancement Compulsory Courses**      2 X 4=8      2X4=8  
(2 Papers of 4 credits each)
- i. Environmental Sciences
  - ii. English/Hindi/SKT

- 2. Skill Enhancement Course**      4 X 4=16      4 X 4=16  
(Skill Based)  
(4 Papers of 4 credits each)

---

**Total credit= 132      Total credit= 132**

**Institute should evolve a system/policy about ECA/ General Interest/ Hobby/ Sports/ NCC/ NSS/ related courses on its own.**

**\*wherever there is practical there will be no tutorials and vice -versa**

**Proposed scheme for choice based credit system in B.Sc. with Zoology (Annual Pattern)**

<b>Bsc. 1st year</b>				
<b>DISCIPLINE SPECIFIC COURSES (DSC)</b>	<b>Credits</b>	<b>Ability enhancement compulsory course (AECC) Credits</b>	<b>Skill enhancement courses (SEC) Credits</b>	<b>Discipline specific elective DSE Credits</b>
<b>DSC IA</b> Animal Diversity ZOOL 101 TH           4 ZOOL 101 PR           2 <b>DSC IB</b> Comparative Anatomy and Developmental Biology of Vertebrates ZOOL 102 TH           4 ZOOL 102 PR           2		i Environmental Sciences ENVS1AECC02           4 ii English ENGL03/Hindi/SKT    4		
<b>IInd year</b>				
<b>DSC IC</b> Physiology and Biochemistry ZOOL 201 TH           4 ZOOL 201 PR           2 <b>DSC ID</b> Genetics and Evolutionary Biology ZOOL 202 TH           4 ZOOL 202 PR           2			<b>SEC-I</b> Medical Diagnostics ZOOL 203 TH           4  <b>SEC-II</b> Apiculture ZOOL 204 TH           4	
<b>IIIrd Year</b>				
			<b>SEC-III</b> Sericulture ZOOL 303 TH           4 <b>SEC- IV</b> Aquarium Fish Keeping ZOOL 304 (A) (TH)    4 <b>OR</b> Research Methodology ZOOL 304 (B) TH     4	<b>DSE IA</b> Applied Zoology ZOOL 301 (A) TH       4 ZOOL 301 (A) PR       2 <b>OR</b> Animal Biotechnology ZOOL 302 (B) TH       4 ZOOL 302 (B) PR       2 <b>OR</b> Aquatic Biology

			ZOOL 303 (C) TH	4
			ZOOL 303 (C)PR	2

			<p><b>DSE IB</b></p> <p>Insect, Vector and Diseases</p> <p>ZOOL 302 (A) TH 4</p> <p>ZOOL 302 (A) PR 2</p> <p><b>OR</b></p> <p>Immunology</p> <p>ZOOL 302 (B) TH 4</p> <p>ZOOL 302 (B) PR 2</p> <p><b>OR</b></p> <p>Reproductive Biology</p> <p>ZOOL 302 (C) TH 4</p> <p>ZOOL 302 (C) PR 2</p>
--	--	--	---

## Detail of Courses

### DISCIPLINE SPECIFIC COURSES (DSC)

#### B.Sc. Ist Year

1. **DSC IA** :Animal Diversity ZOOLOGY 101 TH; ZOOLOGY 101 PR
2. **DSC IB** : Comparative Anatomy and Development Biology of Vertebrates ZOOLOGY 102 TH; ZOOLOGY 102 PR

#### B.Sc. IInd year

3. **DSC IC**: Physiology and Biochemistry ZOOLOGY 201 TH; ZOOLOGY 201 PR
4. **DSC ID**: Genetics and Evolutionary Biology ZOOLOGY 202 TH; ZOOLOGY 202 PR

### Discipline specific elective (DSE)

#### B.Sc. IIIrd year

##### DSE IA

1. Applied Zoology ZOOLOGY 301 (A)TH; ZOOLOGY 301 (A)PR  
OR  
2. Animal Biotechnology ZOOLOGY 301 (B)TH; ZOOLOGY 301 (B) PR  
OR  
3. Aquatic Biology ZOOLOGY 301 (C) TH; ZOOLOGY 301 (C)PR

##### DSE IB

4. Insect, Vector and Diseases ZOOLOGY 302(A) TH; ZOOLOGY 302 (A) PR  
OR  
5. Immunology ZOOLOGY 302(B) TH; ZOOLOGY 302 (B) PR  
OR  
6. Reproductive Biology ZOOLOGY 302 (C) TH; ZOOLOGY 302 (C)PR

### Ability Enhancement Compulsory Courses

#### B.Sc Ist Year

1. Environmental Sciences
2. English/Hindi/SKT

### Skill Enhancement Courses in Zoology

#### B.Sc IInd Year

1. Medical Diagnosis ZOOLOGY 203 TH
2. Apiculture ZOOLOGY 204 TH

#### B.Sc. IIIrd year

3. Sericulture ZOOLOGY 303 TH
4. Aquarium Fish Keeping ZOOLOGY 304 (A) TH  
OR  
Research Methodology ZOOLOGY 304 (B) TH

**ANIMAL DIVERSITY**

**Code: ZOOL 101 TH**

**THEORY**

**(CREDITS 4)**

**Section A**

**Unit 1: Kingdom Protista**

**4**

General characters and classification up to classes; Locomotory Organelles and locomotion in Protozoa

**Unit 2: Phylum Porifera**

**3**

General characters and classification up to classes; Canal System in *Sycon*

**Unit 3: Phylum Cnidaria**

**3**

General characters and classification up to classes; Polymorphism in Hydrozoa

**Unit 4: Phylum Platyhelminthes**

**3**

General characters and classification up to classes; Life history of *Taenia solium*

**Unit 5: Phylum Nematelminthes**

**5**

General characters and classification up to classes; Life history of *Ascaris lumbricoides* and its parasitic adaptations

**Section B**

**Unit 6: Phylum Annelida**

**3**

General characters and classification up to classes; Metamerism in Annelida

**Unit 7: Phylum Arthropoda**

**5**

General characters and classification up to classes; Vision in Arthropoda, Metamorphosis in Insects

**Unit 8: Phylum Mollusca**

**4**

General characters and classification up to classes; Torsion in gastropods

**Unit 9: Phylum Echinodermata**

**4**

General characters and classification up to classes; Water-vascular system in Asteroidea

**Section C**

**Unit 10: Protochordates**

**2**

General features and Phylogeny of Protochordata

**Unit 11: Agnatha**

**2**



General features of Agnatha and classification of cyclostomes up to classes

**Unit 12: Pisces** 4

General features and Classification up to orders; Osmoregulation in Fishes

**Unit 13: Amphibia** 4

General features and Classification up to orders; Parental care

**Section D**

**Unit 14: Reptiles** 4

General features and Classification up to orders; Poisonous and non-poisonous snakes, Biting mechanism in snakes

**Unit 15: Aves** 5

General features and Classification up to orders; Flight adaptations in birds

**Unit 17: Mammals** 5

Classification up to orders; Origin of mammals

## ANIMAL DIVERSITY

Code: ZOOL 101 PR

### PRACTICAL

(CREDITS 2)

1. Study of the following specimens:

*Amoeba, Euglena, Plasmodium, Paramecium, Sycon, Hyalonema, and Euplectella, Obelia, Physalia, Aurelia, Tubipora, Metridium, Taenia solium, Male and female Ascaris lumbricoides, Aphrodite, Nereis, Pheretima, Hirudinaria, Palaemon, Cancer, Limulus, Palamnaeus, Scolopendra, Julus, Periplaneta, Apis, Chiton, Dentalium, Pila, Unio, Loligo, Sepia, Octopus, Pentaceros, Ophiura, Echinus, Cucumaria* and

*Antedon, Balanoglossus, Herdmania, Branchiostoma, Petromyzon, Sphyrna, Pristis, Torpedo, Labeo, Exocoetus, Anguilla, Ichthyophis/Ureotyphlus, Salamandra, Bufo, Hyla, Chelone, Hemidactylus, Chamaeleon, Draco, Vipera, Naja, Crocodylus, Gavialis, Any six common birds from different orders, Sorex, Bat, Funambulus, Loris*

2. Study of the following permanent slides:

T.S. and L.S. of *Sycon*, Study of life history stages of *Taenia*, T.S. of Male and female *Ascaris*

3. Key for Identification of poisonous and non-poisonous snakes
4. Project on any topic from theory.

### SUGGESTED READINGS

- Ruppert and Barnes, R.D. (2006). *Invertebrate Zoology*, VIII Edition. Holt Saunders International Edition. □
- Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002). *The Invertebrates: A New Synthesis*, III Edition, Blackwell Science □
- Young, J. Z. (2004). *The Life of Vertebrates*. III Edition. Oxford university press. □
- Pough H. *Vertebrate life*, VIII Edition, Pearson International. □
- Hall B.K. and Hallgrimsson B. (2008). *Strickberger's Evolution*. IV Edition. Jones and Bartlett Publishers Inc. □

**DSC IB**  
**COMPARATIVE ANATOMY AND DEVELOPMENTAL BIOLOGY OF**  
**VERTEBRATES**

**Code: ZOOL 102 TH**

**THEORY** Section A **(CREDITS 4)**

**Unit 1: Integumentary System** **4**

Derivatives of integument w.r.t. glands and digital tips

**Unit 2: Skeletal System** **3**

Evolution of visceral arches

**Unit 3: Digestive System** **4**

Brief account of alimentary canal and digestive glands

**Unit 4: Respiratory System** **5**

Brief account of Gills, lungs, air sacs and swim bladder

**Section B**

**Unit 5: Circulatory System** **4**

Evolution of heart and aortic arches

**Unit 6: Urinogenital System** **4**

Succession of kidney, Evolution of urinogenital ducts

**Unit 7: Nervous System** **3**

Comparative account of brain

**Unit 8: Sense Organs** **3**

Types of receptors

**Section C**

**Unit 9: Early Embryonic Development** **14**

Gametogenesis: Spermatogenesis and oogenesis w.r.t. mammals, vitellogenesis in birds; Fertilization: external (amphibians), internal (mammals), blocks to polyspermy; Early development of frog and humans (structure of mature egg and its membranes, patterns of cleavage, fate map, up to formation of gastrula); types of morphogenetic movements; Fate of germ layers;

**Section D**

**Unit 10: Late Embryonic Development** **12**

Implantation of embryo in humans, Formation of human placenta and functions, other types of placenta on the basis of histology; Metamorphic events in frog life cycle and its hormonal regulation.

**Unit 11: Control of Development**

**4**

Intercellular communication, cell movements and cell death.

**COMPARATIVE ANATOMY AND DEVELOPMENTAL BIOLOGY OF  
VERTEBRATES**

**Code: ZOOL 102 PR  
PRACTICAL (CREDITS 2)**

1 . Osteology:

- a) Disarticulated skeleton of frog and rabbit
- b) Carapace and plastron of Frog /tortoise

2. Frog - Study of developmental stages - whole mounts and sections through permanent slides – cleavage stages, blastula, gastrula, neurula, tail bud stage, tadpole external and internal gill stages.

3. Study of the different types of placenta- histological sections through permanent slides or photomicrographs.

4 . Study of placental development in humans by ultrasound scans as project.

5. Examination of gametes - frog/rat - sperm and ova through permanent slides or photomicrographs.

**SUGGESTED READINGS**

- Kardong, K.V. (2005) *Vertebrates' Comparative Anatomy, Function and Evolution*. IV Edition. McGraw-Hill Higher Education. □
- Kent, G.C. and Carr R.K. (2000). *Comparative Anatomy of the Vertebrates*. IX Edition. The McGraw-Hill Companies. □
- Hilderbrand, M and Gaslow G.E. *Analysis of Vertebrate Structure*, John Wiley and □ Sons. □
- Walter, H.E. and Sayles, L.P; *Biology of Vertebrates*, Khosla Publishing House. □
- Gilbert, S. F. (2006). *Developmental Biology*, VIII Edition, Sinauer Associates, □ Inc., Publishers, Sunderland, Massachusetts, USA. □
- Balinsky, B.I. (2008). *An introduction to Embryology*, International Thomson □ Computer Press. □
- Carlson, Bruce M (1996). *Patten's Foundations of Embryology*, McGraw Hill, Inc. □

**B.Sc. IInd Year**  
**DSC IC**  
**PHYSIOLOGY AND BIOCHEMISTRY**  
**Code: ZOOL 201 TH**

<b>THEORY</b>	<b>(CREDITS 4)</b>
<b>Section A</b>	
<b>Unit 1: Nerve and muscle</b>	<b>8</b>
Structure of a neuron, Resting membrane potential, Graded potential, Origin of Action potential and its propagation in myelinated and non-myelinated nerve fibres, Ultrastructure of skeletal muscle, Molecular and chemical basis of muscle contraction	
<b>Unit 2: Digestion</b>	<b>5</b>
Physiology of digestion in the alimentary canal; Absorption of carbohydrates, proteins, lipids	
<b>Unit 3: Respiration</b>	<b>5</b>
Pulmonary ventilation, Respiratory volumes and capacities, Transport of Oxygen and carbon dioxide in blood	
<b>Section B</b>	
<b>Unit 4: Excretion</b>	<b>5</b>
Structure of nephron, Mechanism of Urine formation, Counter-current Mechanism	
<b>Unit 5: Cardiovascular system</b>	<b>6</b>
Composition of blood, Hemostasis, Structure of Heart, Origin and conduction of the cardiac impulse, Cardiac cycle	
<b>Unit 6: Reproduction and Endocrine Glands</b>	<b>7</b>
Physiology of male reproduction: hormonal control of spermatogenesis; Physiology of female reproduction: hormonal control of menstrual cycle Structure and function of pituitary, thyroid, Parathyroid, pancreas and adrenal	
<b>Section C</b>	
<b>Unit 7: Carbohydrate Metabolism</b>	<b>8</b>
Glycolysis, Krebs Cycle, Pentose phosphate pathway, Gluconeogenesis, Glycogen metabolism, Review of electron transport chain	
<b>Unit 8: Lipid Metabolism</b>	<b>5</b>
$\beta$ oxidation of palmitic acid	
<b><u>Section D</u></b>	
<b>Unit 9: Protein metabolism</b>	<b>5</b>

**Unit 10: Enzymes**

Introduction, Mechanism of action, Inhibition and Regulation

**B.Sc. IInd Year**

**PHYSIOLOGY AND BIOCHEMISTRY**

**Code: ZOOL 201 PR**

**PRACTICAL(CREDITS 2)**

1. Preparation of hemin and hemochromogen crystals
2. Study of permanent histological sections of mammalian pituitary, thyroid, pancreas, adrenal gland
3. Study of permanent slides of spinal cord, duodenum, liver, lung, kidney, bone, cartilage
4. Qualitative tests to identify functional groups of carbohydrates in given solutions (Glucose, Fructose, Sucrose, Lactose).
5. Estimation of total protein in given solutions by Lowry's method.
6. Study of activity of salivary amylase under optimum conditions

**SUGGESTED READINGS**

- Tortora, G.J. and Derrickson, B.H. (2009). *Principles of Anatomy and Physiology*, XII Edition, John Wiley & Sons, Inc. □
- Widmaier, E.P., Raff, H. and Strang, K.T. (2008) *Vander's Human Physiology*, XI Edition., McGraw Hill □
- Guyton, A.C. and Hall, J.E. (2011). *Textbook of Medical Physiology*, XII Edition, Harcourt Asia Pvt. Ltd/ W.B. Saunders Company □
- Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). *Biochemistry*. VI Edition. W.H □ Freeman and Co. □
- Nelson, D. L., Cox, M. M. and Lehninger, A.L. (2009). *Principles of Biochemistry*. IV Edition. W.H. Freeman and Co. □
- Murray, R.K., Granner, D.K., Mayes, P.A. and Rodwell, V.W. (2009). *Harper's Illustrated Biochemistry*. XXVIII Edition. Lange Medical Books/Mc Graw3Hill. □

**DSC ID**  
**GENETICS AND EVOLUTIONARY BIOLOGY**  
**Code: ZOOL 202 TH**

**THEORY**

**(CREDITS 4)**

**Section A**

**Unit 1: Introduction to Genetics**

**3**

Mendel's work on transmission of traits, Genetic Variation, Molecular basis of Genetic Information

**Unit 2: Mendelian Genetics and its Extension**

**8**

Principles of Inheritance, Chromosome theory of inheritance, Incomplete dominance and co-dominance, Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, sex linked inheritance, extra-chromosomal inheritance

**Section B**

**Unit 3: Linkage, Crossing Over and Chromosomal Mapping**

**9**

Linkage and crossing over, Recombination frequency as a measure of linkage intensity, two factor and three factor crosses, Interference and coincidence.

**Unit 4: Mutations**

**7**

Chromosomal Mutations: Deletion, Duplication, Inversion, Translocation, Aneuploidy and Polyploidy; Gene mutations: Induced versus Spontaneous mutations, Back versus Suppressor mutations,

**Unit 5: Sex Determination**

**2**

Chromosomal mechanisms, dosage compensation

**Section C**

**Unit 6: History of Life**

**2**

Major Events in History of Life

**Unit 7: Introduction to Evolutionary Theories** Lamarckism, Darwinism, Neo-Darwinism

**4**

**Unit 8: Direct Evidences of Evolution**

**4**

Types of fossils, Incompleteness of fossil record, Dating of fossils, Phylogeny of horse

**Unit 9: Processes of Evolutionary Change**

**8**

Organic variations; Isolating Mechanisms; Natural selection (Example: Industrial melanism); Types of natural selection (Directional, Stabilizing, Disruptive), Artificial selection

**Section D**



**Unit 10: Species Concept**

Biological species concept (Advantages and Limitations); Modes of speciation (Allopatric, Sympatric)

5

**Unit 11: Macro-evolution**

Macro-evolutionary Principles (example: Darwin's Finches)

4

**Unit 12: Extinction**

Mass extinction (Causes, Names of five major extinctions),  
Role of extinction in evolution

4

**GENETICS AND EVOLUTIONARY****BIOLOGY Code: ZOOL 202 PR****PRACTICAL****(CREDITS 2)**

1. Study of Mendelian Inheritance and gene interactions (Non Mendelian Inheritance) using suitable examples. Verify the results using Chi-square test.
2. Study of Linkage, recombination, gene mapping using the data.
3. Study of Human Karyotypes (normal and abnormal).
4. Study of fossil evidences from plaster cast models and pictures
5. Study of homology and analogy from suitable specimens/  
pictures
6. Charts:
  - a) Phylogeny of horse with diagrams/ cut outs of limbs and teeth of horse ancestors
  - b) Darwin's Finches with diagrams/ cut outs of beaks of different species
7. Visit to Natural History Museum and submission of report

**SUGGESTED READINGS**

- Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). *Principles of Genetics*. VIII Edition. Wiley India. □
- Snustad, D.P., Simmons, M.J. (2009). *Principles of Genetics*. V Edition. John Wiley and Sons Inc. □
- Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). *Concepts of Genetics*. X Edition. Benjamin Cummings. □
- Russell, P. J. (2009). *Genetics- A Molecular Approach*. III Edition. Benjamin Cummings. □

- Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. *Introduction to Genetic Analysis*. IX Edition. W. H. Freeman and Co. □
- Ridley, M. (2004). *Evolution*. III Edition. Blackwell Publishing □
- Barton, N. H., Briggs, D. E. G., Eisen, J. A., Goldstein, D. B. and Patel, N. H. □ (2007). *Evolution*. Cold Spring, Harbour Laboratory Press. □
- Hall, B. K. and Hallgrimsson, B. (2008). *Evolution*. IV Edition. Jones and □ Bartlett Publishers □
- Campbell, N. A. and Reece J. B. (2011). *Biology*. IX Edition, Pearson, Benjamin, Cummings. □
- Douglas, J. Futuyma (1997). *Evolutionary Biology*. Sinauer Associates. □

**BSC IIIrd Year**  
**Discipline Specific Elective**

**DSE IA**

**APPLIED ZOOLOGY ZOOL 301 (A) TH**

**THEORY**

**(CREDITS 4)**

<b>Unit 1: Introduction to Host-parasite Relationship</b>	<b>3</b>
Host, Definitive host, Intermediate host, Parasitism, Symbiosis, Commensalism, Reservoir, Zoonosis	
<b>Unit 2: Epidemiology of Diseases</b>	<b>7</b>
Transmission, Prevention and control of diseases: Tuberculosis, typhoid	
<b>Unit 3: Rickettsiae and Spirochaetes</b>	<b>6</b>
Brief account of <i>Rickettsia prowazekii</i> , <i>Borrelia recurrentis</i> and <i>Treponema pallidum</i>	
<b>Unit 4: Parasitic Protozoa</b>	<b>8</b>
Life history and pathogenicity of <i>Entamoeba histolytica</i> , <i>Plasmodium vivax</i> and <i>Trypanosoma gambiense</i>	
<b>Unit 5: Parasitic Helminthes</b>	<b>5</b>
Life history and pathogenicity of <i>Ancylostoma duodenale</i> and <i>Wuchereria bancrofti</i>	
<b>Unit 6: Insects of Economic Importance</b>	<b>8</b>
Biology, Control and damage caused by <i>Helicoverpa armigera</i> , <i>Pyrilla perpusilla</i> and <i>Papilio demoleus</i> , <i>Callosobruchus chinensis</i> , <i>Sitophilus oryzae</i> and <i>Tribolium castaneum</i>	

**24**

**Unit 7: Insects of Medical Importance****8**

Medical importance and control of *Pediculus humanus corporis*, *Anopheles*, *Culex*, *Aedes*, *Xenopsylla cheopis*

**Unit 8: Animal Husbandry****5**

Preservation and artificial insemination in cattle; Induction of early puberty and synchronization of estrus in cattle

**Unit 9: Poultry Farming****5**

Principles of poultry breeding, Management of breeding stock and broilers, Processing and preservation of eggs

**Unit 10: Fish Technology****5**

Genetic improvements in aquaculture industry; Induced breeding and transportation of fish see

**APPLIED ZOOLOGY**  
**Code: ZOOL 301 (A) PR**

**PRACTICAL****(CREDITS 2)**

1. Study of *Plasmodium vivax*, *Entamoeba histolytica*, *Trypanosoma gambiense*, *Ancylostoma duodenale* and *Wuchereria bancrofti* and their life stages through permanent slides/photomicrographs or specimens.
2. Study of arthropod vectors associated with human diseases: *Pediculus*, *Culex*, *Anopheles*, *Aedes* and *Xenopsylla*.
3. Study of insect damage to different plant parts/stored grains through damaged products/photographs.
4. Identifying feature and economic importance of *Helicoverpa (Heliothis) armigera*, *Papilio demoleus*, *Pyrilla perpusilla*, *Callosobruchus chinensis*, *Sitophilus oryzae* and *Tribolium castaneum*
5. Visit to poultry farm or animal breeding centre. Submission of visit report
6. Maintenance of freshwater aquarium

## SUGGESTED READINGS

- Park, K. (2007). *Preventive and Social Medicine*. XVI Edition. B.B Publishers. □
- Arora, D. R and Arora, B. (2001). *Medical Parasitology*. II Edition. CBS Publications and Distributors. □
- Kumar and Corton. *Pathological Basis of Diseases*. □
- Atwal, A.S. (1986). *Agricultural Pests of India and South East Asia*, Kalyani □ Publishers. □
- Dennis, H. (2009). *Agricultural Entomology*. Timber Press (OR). □
- Hafez, E. S. E. (1962). *Reproduction in Farm Animals*. Lea & Fabiger Publisher □ □ Dunham
- R.A. (2004). *Aquaculture and Fisheries Biotechnology Genetic Approaches*. CABI publications, U.K. □
- Pedigo, L.P. (2002). *Entomology and Pest Management*, Prentice Hall. □

## ANIMAL BIOTECHNOLOGY

Code: ZOOL 301(B) TH

### THEORY

(Credits 4)

#### Unit 1: Introduction

8

Concept and scope of biotechnology

#### Unit 2: Molecular Techniques in Gene manipulation

24

Cloning vectors: Plasmids, Cosmids, Phagemids, Lambda Bacteriophage, M13, BAC, YAC, MAC and Expression vectors (characteristics)

Restriction enzymes: Nomenclature, detailed study of Type II

Transformation techniques: Calcium chloride method and electroporation.

Construction of genomic and cDNA libraries and screening by colony and plaque hybridization

Southern, Northern and Western blotting; DNA sequencing: Sanger method  
Polymerase Chain Reaction, DNA Finger Printing and DNA micro array

### **Unit 3: Genetically Modified Organisms**

**18**

Production of cloned and transgenic animals: Nuclear Transplantation, Retroviral Method, DNA microinjection

Applications of transgenic animals: Production of pharmaceuticals, production of donor organs, knockout mice.

Production of transgenic plants: *Agrobacterium* mediated transformation.

Applications of transgenic plants: insect and herbicide resistant plants.

### **Unit 4: Culture Techniques and Applications**

**10**

Animal cell culture, Expressing cloned genes in mammalian cells, Molecular diagnosis of genetic diseases (Cystic fibrosis, Sickle cell anemia)

Recombinant DNA in medicines: Recombinant insulin and human growth hormone, Gene therapy

**DSE IA**  
**ANIMAL BIOTECHNOLOGY**  
**Code: ZOOL 301(B) PR**

**PRACTICAL**

**(Credits 2)**

1. Genomic DNA isolation from *E. coli*
2. Plasmid DNA isolation (pUC 18/19) from *E. coli*
3. Restriction digestion of plasmid DNA.
4. Construction of circular and linear restriction map from the data provided.
5. Calculation of transformation efficiency from the data provided.
6. To study following techniques through photographs
  - a) Southern Blotting
  - b) Northern Blotting
  - c) Western Blotting
  - d) DNA Sequencing (Sanger's Method)
  - e) PCR

DNA fingerprinting

7. Project report on animal cell culture

**SUGGESTED READINGS**

- Brown, T.A. (1998). Molecular Biology Labfax II: Gene Cloning and DNA Analysis. II Edition, Academic Press, California, USA.
- Glick, B.R. and Pasternak, J.J. (2009). Molecular Biotechnology - Principles and Applications of Recombinant DNA. IV Edition, ASM press, Washington, USA.
- Griffiths, A.J.F., J.H. Miller, Suzuki, D.T., Lewontin, R.C. and Gelbart, W.M. (2009). An Introduction to Genetic Analysis. IX
- Snustad, D.P. and Simmons, M.J. (2009). Principles of Genetics. V Edition, John Wiley and Sons Inc.
- Watson, J.D., Myers, R.M., Caudy, A. and Witkowski, J.K. (2007). Recombinant DNA-Genes and Genomes- A Short Course. III Edition, Freeman and Co., N.Y., USA.
- Beauchamp, T.I. and Childress, J.F. (2008). Principles of Biomedical Ethics. VI Edition, Oxford University Press.

**DSE IA**

**AQUATIC BIOLOGY**

**Code: ZOOL 301 (C) TH**

**THEORY**

**(Credits 4)**

**UNIT 1: Aquatic Biomes**

**15**

Brief introduction of the aquatic biomes: Freshwater ecosystem (lakes, wetlands, streams and rivers), estuaries, intertidal zones, oceanic pelagic zone, marine benthic zone and coral reefs.

**UNIT 2: Freshwater Biology**

**20**

**Lakes:** Origin and classification, Lake as an Ecosystem, Lake morphometry, Physico-chemical Characteristics: Light, Temperature, Thermal stratification, Dissolved Solids, Carbonate, Bicarbonates, Phosphates and Nitrates, Turbidity; dissolved gases (Oxygen, Carbon dioxide). Nutrient Cycles in Lakes-Nitrogen, Sulphur and Phosphorous.

**Streams:** Different stages of stream development, Physico-chemical environment, Adaptation of hill-stream fishes.

**UNIT 3: Marine Biology**

**10**

Salinity and density of Sea water, Continental shelf, Adaptations of deep sea organisms, Coral reefs, Sea weeds.

**UNIT 4: Management of Aquatic Resources**

**15**

Causes of pollution: Agricultural, Industrial, Sewage, Thermal and Oil spills, Eutrophication, Management and conservation (legislations), Sewage treatment Water quality assessment- BOD and COD.

**AQUATIC BIOLOGY**

**Code: ZOOL 301 (C) PR**

**PRACTICAL**

**(Credits 2)**

1. Determine the area of a lake using graphimetric and gravimetric method.
2. Identify the important macrophytes, phytoplanktons and zooplanktons present in a lake ecosystem.
3. Determine the amount of Turbidity/transparency, Dissolved Oxygen, Free Carbon dioxide, Alkalinity (carbonates & bicarbonates) in water collected from a nearby lake/ water body.



4. Instruments used in limnology (Secchi disc, Van Dorn Bottle, Conductivity meter, Turbidity meter, PONAR grab sampler) and their significance.
5. A Project Report on a visit to a Sewage treatment plant/Marine bioreserve/Fisheries Institutes.

### SUGGESTED READINGS

- **Anathakrishnan** : Bioresources Ecology 3<sup>rd</sup> Edition □  
□
- **Goldman** : Limnology, 2<sup>nd</sup> Edition □  
□
- **Odum and Barrett** : Fundamentals of Ecology, 5<sup>th</sup> Edition □  
□
- **Pawlowski** : Physicochemical Methods for Water and Wastewater Treatment, 1<sup>st</sup> Edition □  
□
- **Wetzel** : Limnology, 3<sup>rd</sup> edition □  
□
- **Trivedi and Goyal** : Chemical and biological methods for water pollution studies □  
□
- **Welch** : Limnology Vols. I-II

### DSE IB

#### INSECT, VECTORS AND DISEASES ZOOLOGY 302(A) TH

### THEORY

(Credits 4)

#### Unit I: Introduction to Insects

6

General Features of Insects, Morphological features, Head – Eyes, Types of antennae, Mouth parts w.r.t. feeding habits

#### Unit III: Insects as Vectors

8

Classification of insects up to orders, detailed features of orders with insects as vectors – Diptera, Siphonaptera, Siphunculata, Hemiptera

**Unit IV: Dipteran as Disease Vectors** **24**  
 Dipterans as important insect vectors – Mosquitoes, Sand fly, Houseflies;  
 Study of mosquito-borne diseases – Malaria, Dengue, Chikungunya, Viral encephalitis, Filariasis;  
 Control of mosquitoes Study of sand fly-borne diseases – Visceral Leishmaniasis, Cutaneous  
 Leishmaniasis, Phlebotomus fever; Control of Sand fly Study of house fly as important mechanical  
 vector, Myiasis, Control of house fly

**Unit IV: Siphonaptera as Disease Vectors** **6**  
 Fleas as important insect vectors; Host-specificity, Study of Flea-borne diseases – Plague,  
 Typhus fever; Control of fleas

**Unit V: Siphunculata as Disease Vectors** **4**  
 Human louse (Head, Body and Pubic louse) as important insect vectors; Study  
 of louse-borne diseases –Typhus fever, Relapsing fever, Trench fever,  
 Vagabond's disease, Phthiriasis; Control of human louse

**Unit VI: Hemiptera as Disease Vectors** **6**  
 Bugs as insect vectors; Blood-sucking bugs; Chagas disease, Bed bugs as mechanical vectors,Control  
 and prevention measures

### **INSECT VECTORS AND DISEASES**

**Code: ZOOL 302 (A) PR**

**RACTICAL**

**(CREDITS 2)**

1. Study of different kinds of mouth parts of insects
2. Study of following insect vectors through permanent slides/ photographs:  
*Aedes, Culex, Anopheles, Pediculus humanus capitis, Pediculus humanus corporis, Phthirus pubis, Xenopsylla cheopis, Cimex lectularius, Phlebotomus argentipes, Musca domestica*, through permanent slides/ photographs
3. Study of different diseases transmitted by above insect vectors

**Submission of a project report on any one of the insect vectors and disease transmitted**

## SUGGESTED READINGS

□

- Imms, A.D. (1977). *A General Text Book of Entomology*. Chapman & Hall, UK □
- Chapman, R.F. (1998). *The Insects: Structure and Function*. IV Edition, Cambridge University Press, UK □

□

□

- Pedigo L.P. (2002). *Entomology and Pest Management*. Prentice Hall Publication □
- Mathews, G. (2011). *Integrated Vector Management: Controlling Vectors of Malaria and Other Insect Vector Borne Diseases*. Wiley-Blackwell □

### DSE IB

### IMMUNOLOGY ZOOL 302(B) TH

#### THEORY

(CREDITS 4)

<b>Unit 1: Overview of the Immune System</b>	<b>10</b>
Introduction to basic concepts in immunology, components of immune system, principles of innate and adaptive immune system	
<b>Unit 2: Cells and Organs of the Immune System</b>	<b>8</b>
Haematopoeisis, Cells of immune system and organs (primary and secondary lymphoid organs) of the immune system	
<b>Unit 3: Antigens</b>	<b>8</b>
Basic properties of antigens, B and T cell epitopes, haptens and adjuvants	
<b>Unit 4: Antibodies</b>	<b>8</b>
Structure, classes and function of antibodies, monoclonal antibodies, antigen antibody interactions as tools for research and diagnosis	
<b>Unit 5: Working of the immune system</b>	<b>12</b>
Structure and functions of MHC, exogenous and endogenous pathways of antigen presentation and processing, Basic properties and functions of cytokines, Complement system: Components and pathways.	
<b>Unit 6: Immune system in health and disease</b>	<b>10</b>
Gell and Coombs' classification and brief description of various types of hypersensitivities, Introduction to concepts of autoimmunity and immunodeficiency,	
<b>Unit 7: Vaccines</b>	<b>4</b>
General introduction to vaccines, Various types of vaccines	

## IMMUNOLOGY ZOOL 302(B) PR

### PRACTICAL

(CREDITS 2)

- 1\*. Demonstration of lymphoid organs
2. Histological study of spleen, thymus and lymph nodes through slides/ photographs
3. Preparation of stained blood film to study various types of blood cells.
4. Ouchterlony's double immuno-diffusion method.
- 5 ABO blood group determination.
- 6\*. Cell counting and viability test from splenocytes of farm bred animals/cell lines.
- 7 . Demonstration of a) ELISA b) Immunoelectrophoresis

(\*Subject to UGC guidelines)

### SUGGESTED READINGS

- Kindt, T. J., Goldsby, R.A., Osborne, B. A. and Kuby, J (2006). *Immunology*, VI Edition. W.H. Freeman and Company. □
- 
- David, M., Jonathan, B., David, R. B. and Ivan R. (2006). *Immunology*, VII Edition, Mosby, Elsevier Publication. □
- 

- Abbas, K. Abul and Lichtman H. Andrew (2003.) *Cellular and Molecular Immunology*. V Edition. Saunders Publication. □

**DSE IB**  
**REPRODUCTIVE BIOLOGY**  
**Code: ZOOL 302(C) TH**

### THEORY

(CREDITS 4)

#### Unit 1: Reproductive Endocrinology

15

Gonadal hormones and mechanism of hormone action, steroids, glycoprotein hormones, and prostaglandins, hypothalamo – hypophyseal – gonadal axis, regulation of gonadotrophin secretion in male and female; Reproductive System: Development and differentiation of gonads, genital ducts, external genitalia, mechanism of sex differentiation.

**Unit 2: Functional anatomy of male reproduction****15**

Outline and histological of male reproductive system in rat and human; Testis: Cellular functions, germ cell, system cell renewal; Spermatogenesis: kinetics and hormonal regulation; Androgen synthesis and metabolism; Epididymal function and sperm maturation; Accessory glands functions; Sperm transportation in male tract

**Unit 3: Functional anatomy of female reproduction****20**

Outline and histological of female reproductive system in rat and human; Ovary: folliculogenesis, ovulation, corpus luteum formation and regression; Steroidogenesis and secretion of ovarian hormones; Reproductive cycles (rat and human) and their regulation, changes in the female tract; Ovum transport in the fallopian tubes; Sperm transport in the female tract, fertilization; Hormonal control of implantation; Hormonal regulation of gestation, pregnancy diagnosis, foeto – maternal relationship; Mechanism of parturition and its hormonal regulation; Lactation and its regulation

**Unit 4: Reproductive Health****10**

Infertility in male and female: causes, diagnosis and management; Assisted Reproductive Technology: sex selection, sperm banks, frozen embryos, in vitro fertilization, ET, EFT, IUT, ZIFT, GIFT, ICSI, PROST; Modern contraceptive technologies; Demographic terminology used in family planning

**REPRODUCTIVE BIOLOGY****Code: ZOOL 302(C) PR****PRACTICAL****(CREDITS 2)**

1. Study of animal house: set up and maintenance of animal house, breeding techniques, care of normal and experimental animals.
2. Examination of vaginal smear rats from live animals.
3. Surgical techniques: principles of surgery in endocrinology. Ovariectomy, hysterectomy, castration and vasectomy in rats.
4. Examination of histological sections from photomicrographs/ permanent slides of rat/human: testis, epididymis and accessory glands of male reproductive systems; Sections of ovary, fallopian tube, uterus (proliferative and secretory stages), cervix and vagina.
5. Human vaginal exfoliate cytology.
6. Sperm count and sperm motility in rat
7. Study of modern contraceptive devices

## SUGGESTED READINGS

□

- Austin, C.R. and Short, R.V. reproduction in Mammals. Cambridge University Press. □
- Degroot, L.J. and Jameson, J.L. (eds). Endocrinology. W.B. Saunders and Company. □

□

- Knobil, E. et al. (eds). The Physiology of Reproduction. Raven Press Ltd. □
- Hatcher, R.A. et al. The Essentials of Contraceptive Technology. Population Information Programme. □

## SKILL ENHANCEMENT COURSES

### SEC 1

### MEDICAL DIAGNOSTICS

Code: ZOOL 203 TH

**THEORY** (Credits 4)

**Unit 1: Introduction to Medical Diagnostics and its Importance** 2

**Unit 2: Diagnostics Methods Used for Analysis of Blood** 15

Blood composition, Preparation of blood smear and Differential Leucocyte Count (D.L.C) using Leishman's stain, Platelet count using haemocytometer, Erythrocyte Sedimentary Rate (E.S.R), Packed Cell Volume (P.C.V.)

**Unit 3: Diagnostic Methods Used for Urine Analysis** 6

Urine Analysis: Physical characteristics; Abnormal constituents

**Unit 4: Non -infectious Diseases** 10

Causes, types, symptoms, complications, diagnosis and prevention of Diabetes (Type I and Type II), Hypertension (Primary and secondary), Testing of blood glucose using Glucometer/Kit

**Unit 5: Infectious Diseases** 6

Causes, types, symptoms, diagnosis and prevention of Tuberculosis and Hepatitis

**Unit 6: Tumours** 6

Types (Benign/Malignant), Detection and metastasis; Medical imaging: X-Ray of Bone fracture, PET, MRI and CT Scan (using photographs).

## SUGGESTED READINGS

- Park, K. (2007), *Preventive and Social Medicine*, B.B. Publishers □
- Godkar P.B. and Godkar D.P. *Textbook of Medical Laboratory Technology*, II □ Edition, Bhalani Publishing House □
- Cheesbrough M., *A Laboratory Manual for Rural Tropical Hospitals, A Basis for Training Courses* □
- Guyton A.C. and Hall J.E. *Textbook of Medical Physiology*, Saunders □
- Robbins and Cortan, *Pathologic Basis of Disease*, VIII Edition, Saunders □
- Prakash, G. (2012), *Lab Manual on Blood Analysis and Medical Diagnostics*, S. Chand and Co. Ltd. □

### Tutorial – 01 Credit

## SEC-II APICULTURE ZOOL 204 TH

(CREDIT 4)

<b>Unit 1: Biology of Bees</b>	<b>(10)</b>
History, Classification and Biology of Honey Bees Social Organization of Bee Colony	
<b>Unit 2: Rearing of Bees</b>	<b>(15)</b>
Artificial Bee rearing (Apiary), Beehives – Newton and Langstroth Bee Pasturage Selection of Bee Species for Apiculture Bee Keeping Equipment Methods of Extraction of Honey (Indigenous and Modern)	
<b>Unit 3: Diseases and Enemies</b>	<b>(8)</b>
Bee Diseases and Enemies Control and Preventive measures	
<b>Unit 4: Bee Economy</b>	<b>(6)</b>
Products of Apiculture Industry and its Uses (Honey, Bees Wax, Propolis), Pollen Etc	
<b>Unit 5: Entrepreneurship in Apiculture</b>	<b>(6)</b>
Bee Keeping Industry – Recent Efforts, Modern Methods in employing artificial Beehives for cross pollination in horticultural gardens	

## SUGGESTED READINGS

- Prost, P. J. (1962). *Apiculture*. Oxford and IBH, New Delhi.
- Bisht D.S., *Apiculture*, ICAR Publication.

### SEC - III SERICULTURE Code: ZOOL 303 TH

(CREDITS 4)

#### **Unit 1: Introduction** (8)

Sericulture: Definition, history and present status; Silk route  
Types of silkworms, Distribution and Races  
Exotic and indigenous races  
Mulberry and non-mulberry Sericulture

#### **Unit 2: Biology of Silkworm** (6)

Life cycle of *Bombyx mori*  
Structure of silk gland and secretion of silk

#### **Unit 3: Rearing of Silkworms** (15)

Selection of mulberry variety and establishment of mulberry garden  
Rearing house and rearing appliances  
Disinfectants: Formalin, bleaching powder, RKO  
Silkworm rearing technology: Early age and Late age rearing  
Types of mountages  
Spinning, harvesting and storage of cocoons

#### **Unit 4: Pests and Diseases** (10)

Pests of silkworm: Uzi fly, dermestid beetles and vertebrates  
Pathogenesis of silkworm diseases: Protozoan, viral, fungal and bacterial  
Control and prevention of pests and diseases

#### **Unit 5: Entrepreneurship in Sericulture** (6)

Prospectus of Sericulture in India: Sericulture industry in different states, employment, potential in mulberry and non-mulberry sericulture. Visit to various sericulture centres.



## SUGGESTED READINGS

- Handbook of Practical Sericulture: S.R. Ullal and M.N. Narasimhanna CSB, Bangalore
- Appropriate Sericultural Techniques; Ed. M. S. Jolly, Director, CSR & TI, Mysore. □ □  
Handbook of Silkworm Rearing: Agriculture and Technical Manual-1, Fuzi  
□ Pub. Co. Ltd., Tokyo, Japan 1972. □
- Manual of Silkworm Egg Production; M. N. Narasimhanna, CSB, Bangalore 1988. □
- Silkworm Rearing; Wupang—Chun and Chen Da-Chung, Pub. By FAO, Rome 1988. □
- A Guide for Bivoltine Sericulture; K. Sengupta, Director, CSR & TI, Mysore 1989. □
- Improved Method of Rearing Young age silkworm; S. Krishnaswamy, reprinted CSB, Bangalore, 1986. □

**Tutorial – 01 Credit**

## SEC – IV AQUARIUM FISH KEEPING Code: ZOO 304 (A) TH (CREDITS 4)

### **Unit 1: Introduction to Aquarium Fish Keeping 10**

The potential scope of Aquarium Fish Industry as a Cottage Industry, Exotic and Endemic species of Aquarium Fishes

### **Unit 2: Biology of Aquarium Fishes 15**

Common characters and sexual dimorphism of Fresh water and Marine Aquarium fishes such as Guppy, Molly, Sword tail, Gold fish, Angel fish, Blue morph, Anemone fish and Butterfly fish

### **Unit 3: Food and feeding of Aquarium fishes 6**

Use of live fish feed organisms. Preparation and composition of formulated fish feeds

### **Unit 4: Fish Transportation 8**

Live fish transport - Fish handling, packing and forwarding techniques.

### **Unit 5: Maintenance of Aquarium 6**

General Aquarium maintenance – budget for setting up an Aquarium Fish Farm as a Cottage Industry

## SUGGESTED READINGS

Mary Bailey, Gina Sandford; *The Complete Guide to Aquarium Fish Keeping (Practical Handbook)*  
Publishers: Lorenz Books

- Mills, Dick; *Keeping Aquarium Fish (Teach Yourself General)* Publisher : Teach Yourself

**OR**

**SEC-IV**  
**RESEARCH METHODOLOGY**  
**Code: ZOOL 304 (B) TH (CREDITS 4)**

**(3+01)**

**Unit 1: Foundations of Research** **8**

Meaning, Objectives, Motivation: Research Methods vs Methodology, Types of Research: Analytical vs Descriptive, Quantitative vs Qualitative, Basic vs Applied

**Unit 2: Research Design** **15**

Need for research design: Features of good design, Important concepts related to good design- Observation and Facts, Prediction and Explanation, Development of Models. Developing a research plan: Problem identification, Experimentation, Determining experimental and sample designs

**Unit 3: Data Collection, Analysis and Report Writing** **15**

Observation and Collection of Data-Methods of data collection- Sampling Methods, Data Processing and Analysis Strategies, Technical Reports and Thesis writing, Preparation of Tables and Bibliography. Data Presentation using digital technology

**Unit 4: Ethical Issues** **7**

Intellectual property Rights, Commercialization, Copy Right, Royalty, Patent law, Plagiarism, Citation, Acknowledgement

**SUGGESTED READINGS**

- Anthony, M, Graziano, A.M. and Raulin, M.L. 2009. Research Methods: A Process of Inquiry, Allyn and Bacon. □
- Walliman, N. 2011. Research Methods- The Basics. Taylor and Francis, London, New York. □
- Wadhera, B.L.: Law Relating to Patents, Trade Marks, Copyright Designs and Geographical Indications, 2002, Universal Law publishing □
- C.R.Kothari: Research Methodology, New Age International, 2009 □
- Coley, S.M. and Scheinberg, C.A. 1990, "Proposal writing". Stage Publications. □

## END SEMESTER EXAMINATION (ESE) OF ZOOLOGY IN B.Sc. PROGRAMME

### THEORY EXAMINATION SCHEME OF EXAMINATION

1. English shall be the medium of instruction and examination.
  2. Examinations shall be conducted at the end of each semester as per the Academic Calendar notified by Himachal Pradesh University.
  3. Each course will carry **100 marks** and will have following components
    1. **Theory Paper End-Semester examination** **50 marks**
    2. **Practicals** **20 marks**
    3. **Internal Assessment** **30 Marks**
- Theory Paper + Practical + Internal Assessment** **(50+20+ 30) =100 marks**

### Scheme of Examination for every course (Core Course, Discipline Specific Elective Course, Generic Elective Course):

End Semester Examination	50 Marks	Time 3 hrs
Practical for every course	20 Marks	Time 3 hrs
Internal Assessment	30 Marks	

### Distribution of Internal Assessment /CCA:

- (i) Class Attendance = 5 Marks
- (ii) Class test to be taken on completion of 40% syllabus by the class teacher = 5 Marks
- (iii) House test to be taken on completion of 75 % of Syllabus = 10 Marks
- (iv) Assignments, tutorials, general behavior of student. = 10 Marks

#### Marks for Class attendance

<input type="checkbox"/> 75% but < 80%	1 marks
<input type="checkbox"/> 80% but <85%	2 marks
<input type="checkbox"/> 85 but <90%	3 marks
<input type="checkbox"/> 90% but < 95%	4 marks
<input type="checkbox"/> 95% To 100%	5 marks

### Skill Enhancement Course & Ability Enhancement Compulsory Course:

**Skill Enhancement Course = 100 Marks (Theory 70 + CCA 30)**

**Ability Enhancement Compulsory Courses: 1. Environment Science = 100 Marks**

2. English/Hindi/SKT = 100 Marks (Theory 70 + CCA 30)

## **Instructions for Setting of Question Papers**

### **I. Discipline Specific Courses and Discipline Specific Electives (Theory Papers)**

**Max Marks: 50**

1. Each question paper will contain 9 questions (divided into five parts A, B, C, D and E) of 10 marks each.
2. Question number 1 in Part A will be compulsory and will contain ten fill in the blanks, multiple choice questions, definitions or terms of one mark each.
3. Rest of the eight questions will be divided into four Parts (B, C, D and E containing questions from Section A, B, C and D of the syllabus) with each Part containing two questions. Students will be required to attempt only one question from each Part. Each question may be divided into 2 parts.
4. Questions should be taken from the whole syllabus.

### **II. Skill Enhancement Courses (SEC)**

**Max Marks: 70**

1. Each question paper will contain 9 questions (divided into five Parts- A, B, C, D and E) of 14 marks each.
2. Question number 1 in Part A will be compulsory and will contain ten fill in the blanks, multiple choice questions, definitions or terms of one mark each.
3. Rest of the eight questions will be divided into four Parts (B, C, D and E containing questions from Section A, B, C and D of the syllabus) with each Part containing two questions. Students will be required to attempt only one question from each Part.
4. Questions should be taken from the whole syllabus.

