TUMKUR UNIVERSITY
TUMAKURU

B.Sc. (UG) ZOOLOGY SYLLABUS

(CBCS)

TUMKUR UNIVERSITY

B.Sc. Programme: Course Structure & Matrix for Semester I, II, III & IV in Zoology – CBCS

Sl. No.	Course Number in Semester I/II/III/IV	Subject, Paper No. and Title in a Semester I/II/III/IV	Type of Instruction and hours per week/ course	Credits	Hours of Exam (SEE) per Course/ Sem.	Maxi. Marks for I.A/ Course/ Sem.	Maxi. Marks for SEE per Course/ Sem.	Maxi. Marks per Course Sem.
1	1.7-I Sem.	Paper No.-I Animal Diversity	T 4	4	3	10	90	100
2	1.8-I Sem.	Practical No-I Based on 1.7 Theory	P 4	2	3	-	50	50
3	2.7-II Sem.	Paper No.-II Comparative and Developmental Biology of Vertebrates	T 4	4	3	10	90	100
4	2.8-II Sem.	Practical No.-II Based on 2.7 Theory	P 4	2	3	-	50	50
5	3.7-III Sem.	Paper No.-III Physiology and Biochemistry	T 4	4	3	10	90	100
6	3.8-III Sem.	Practical No.-III Based on 3.7 Theory	P 4	2	3	-	50	50
7	4.7-IV Sem.	Paper No.-IV Insects, Vectors and Diseases	T 4	4	3	10	90	100
8	4.8-IV Sem.	Practical No.-IV Based on 4.7 Theory	P 4	2	3	-	50	50
Group III Compulsory Courses and open elective (Mandatory for the combination of B.Sc. Programme; not to be considered for declaration of class and rank)								
	8 Courses / Semesters (4T &4 P)	**8 Courses for four Semesters (4T &4 P)**	**32 Hours / Week**	**24**	**24**	**40**	**560**	**600**
9	4.9- IV Sem.	Open Elective Paper Apiculture	2 T	2	3	-	50	50

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TUMKUR UNIVERSITY

B.Sc. Programme: Course Structure & Matrix for semester V&VI in Zoology – CBCS

Sl. No.	Course Number* in Sem. V/VI	Subject, Paper No. and Title in a Semester V/VI	Type of Instruction and hours per week/Type	Credits	Hours of Exam (SEE) per Course/ Sem.	Maxi. Marks for I.A/ Course/ Sem.	Maxi. Marks for SEE per Course / Sem.	Maxi. Marks per Course Sem.
10	5.7-V Sem.	Paper No.- V Genetics and Evolutionary Biology	T 3	3	3	10	90	100
11	5.8 –V Sem.	Paper No.VI-Cell Biology, Immunology and Animal Biotechnology	T 3	3	3	10	90	100
12	5.9A-V Sem.	Practical No.- V Based on 5.7 Theory	P 3	3	3	-	50	50
13	5.9B-V Sem.	Practical No.-VI Based on 5.8 Theory	P 3		3	-	50	50
14	6.7- VI Sem.	Paper No. -VII Applied Zoology	T 3	4	3	10	90	100
15	6.8- VI Sem.	Paper No.-VIII Environmental Biology and Ethology	T 3	4	3	10	90	100
16	6.9A-VI Sem.	Practical No. -VII Based on 6.7 Theory	P 3	3	3	-	50	50
17	6.9B- VI Sem.	Practical No.-VIII Based on 6.8 Theory	P 3		3	-	50	50
		8 Courses for VI & VII Sem. (4T &4P)	**24 Hours / Week**	**20**	**24**	**40**	**560**	**600**
Total		**16 Courses for I / II/III/IV/V/VI Sem.(excluding OET Paper) (8T &8P)**	**56 Hours / Week**	**44**	**48**	**80**	**1120**	**1200**

I SEMESTER ZOOLOGY

1.7:-PAPER I -ANIMAL DIVERSITY

CREDITS 4 - 60 Hours

UNIT -1: KINGDOM PROTISTA **04hrs.**

1. General characters and classification up to classes with suitable examples 02 hrs.
2. Locomotory organelles in Protozoa: Pseudopodia, Flagella, cilia and myonemes Locomotion in Protozoa: Amoeboid Movement and Sol- Gel Theory, Euglenoid movement and Flagellar movement, Ciliary movement and Paddle- Stroke Theory 02 hrs.

UNIT-2: PHYLUM PORIFERA **03 hrs**.

1. General characters and classification up to classes with suitable examples 02 hrs.
2. Canal system in Sycon 01 hrs.

UNIT- 3: PHYLUM CNIDARIA **03 hrs.**

1. General characters and classification up to classes with suitable examples 02 hrs.
2. Polymorphism in Hydrozoan with respect to Obelia 01 hrs.

UNIT- 4: PHYLUM PLATYHELMINTHES **03 hrs.**

1. General characters and classification up to classes with suitable examples 02 hrs.
2. Life history of *Taenia solium* 01 hrs.

UNIT- 5: PHYLUM NEMATHELMINTHES **05 hrs.**

1. General characters of Nematodes with examples 02 hrs.
2. Structure (sexual dimorphism) and life history of *Ascaris lumbricoides* and its Parasitic adaptations. 03 hrs.

UNIT- 6: PHYLUM ANNELIDA **03 hrs.**

1. General characters and classification up to classes with suitable examples 02 hrs.
2. Metamerism and its significance in Annelids. 01 hrs.

UNIT-7: PHYLUM ARTHROPODA **05 hrs.**

1. General characters and classification up to classes with suitable examples 02 hrs.
2. Vision in Arthropoda: Compound eye in Palaemon (Mosaic vision) and Simple eye in Scorpion 02 hrs.
3. Metamorphosis in insects – (Ametabola, Hemimetabola, Paurometabola, Hypermetabola, Holometabola). 01hrs.

UNIT- 8: Phylum Mollusca **04 hrs.**

1. General characters and classification up to classes with suitable examples 02 hrs.
2. Torsion in Gastropods 02 hrs.

UNIT- 9: PHYLUM ECHINODERMATA **04 hrs.**

1. General characters and classification up to classes with suitable examples 02 hrs.
2. Water Vascular System in Asterias 02 hrs.

UNIT- 10: PROTOCHORDATA **02 hrs.**

1. General features 01 hrs.
2. Phylogeny of Protochordates 01 hrs.

UNIT- 11: AGNATHA **02 hrs.**

1. General features and its classification up to classes with suitable examples 01 hrs.
2. Differences between Hag fishes and Lampreys 01 hrs.

UNIT- 12: PISCES **04 hrs.**

1. General characters and classification up to orders 02 hrs.
2. Osmo-regulation in Fishes – Fresh water and marine water Teleosts 02 hrs.

UNIT- 13: AMPHIBIA **04 hrs.**

1. General characters and classification up to orders 02 hrs.
2. Parental care in Amphibia- , Ichthyophis, Alytes, Pipa and Gastrotheca. 02 hrs.

UNIT- 14: REPTILES **04 hrs.**

1. General characters and classification up to living orders 02 hrs.
2. Poisonous and Non- Poisonous snakes 01 hrs.
3. Poison apparatus, composition of Venom and its effects. Biting mechanism in Snakes 01hrs.

UNIT- 15: AVES **05 hrs.**

1. General characters and mention the living orders with examples 02hrs.
2. Flight adaptations in Birds 02 hrs.
3. Interesting features of Ratitae and Carinatae 01 hrs.

UNIT-16: MAMMALS **05 hrs.**

1. General characters and classification up to living orders 02 hrs.
2. Interesting features of Prototheria, Metatheria and Eutheria 02 hrs.
3. Origin of mammals 01 hrs.

REFERENCES:

- Invertebrate Zoology - E. L. Jordan and Verma
- Modern text book of Zoology-Invertebrates- R. L. Kotpal
- Biology of Animals Vol-1- Ganguly, Sinha, Adhikari
- Zoology for degree students- Dr. V.K. Agarwal
- Modern text book of Zoology-Vertebrates - R. L. Kotpal

I SEMESTER PRACTICAL-I (1.8)

BASED ON ANIMAL DIVERSITY

CREDITS 2 -15 UNITS

1. PHYLUM: PROTOZOA

Observation of water samples for the live Protozoan, Study of Amoeba, Euglena, Plasmodium and Paramecium. **01 Unit**

2. PHYLUM: PORIFERA

Sycon, Hyalonema and Euplectella. Slides of T.S and L.S of Sycon.

3. PHYLUM: COELENTERATA **02 Units**

Obelia, Physalia, Aurelia, Tubifora and Meandrina or Fungia
Whole mount preparation of coelenterate colony.

4. PHYLUM: PLATY HELMINTHES AND NEMATHELMINTHES

Taenia solium, Male and female *Ascaris lumbricoides,* T.S of male and female Ascaris.

5. PHYLUM: ANNELIDA. **02 Units**

Aphrodite, Neries and Leech

6. PHYLUM: ARTHROPODA

Palaeomon, Limulus, Centipede, Millepede, Spider, Apis and Stick insect

7. PHYLUM: MOLLUSCA **02 Units**

Chiton, Mytilus,Octopus, Shells of Dentalium, Pila, Sepia

8. PHYLUM: ECHINODERMATA

Asterias, Ophiura, Sea urchin, Cucumaria, Antedon, Bipinnaria larva, Echinopluteus larva

9. PROTOCHORDATA AND CYCLOSTOMATA **02 Units**

Balanoglossus, Ascidia, Branchiostoma, Petromyzon.

10. PISCES

Pristis, Labeo, Exocoetus, Anguilla.

11. AMPHIBIA **01 Unit**

Study of specimen of Ichthyophis, Ureotyphlus, Salamandra, Bufo,Hyla

12. REPTILIA **02 Units**

Chelone, Chameleon, Draco,Viper, Naja, Crocodylus.

13. BIRDS

Sparrow, Pigeon, Parrot, Duck, King Fisher, Hawk

14. MAMMALS **01 Unit**

Bat, Funambulus, Loris

15. Identification of poisonous and non-poisonous snakes **02 Units**

16. Preparation of animal album containing Photographs, cut outs, with appropriate write up about the above mentioned taxa. Different taxa/topics may be given to different sets of students.

(Invertebrates-05, Vertebrates-05)

Note: Charts, Photographs and models can be shown.

I SEMESTER ZOOLOGY

PRACTICAL –I (1.8) BASED ON ANIMAL DIVERSITY

SCHEME OF EXAMINATION

Duration: 3 hrs. **Max. Marks: 50**

Q.1. Identify and comment on A to E (5 X 3) =15Marks

(Protozoa to Echinodermata)

Q.2 .Identify and comment on F to H (3 X 3) =09 Marks

(Protochordates to Mammals)

Q.3 .Whole mount preparation of coelenterate colony 06 Marks

Q.4. Identification of poisonous and non-poisonous snakes 05 Marks

Q.4. Submission of Animal album 05 Marks

Q.5. Viva-voce

(Life history of Taenia solium, Sexual dimorphism in Ascaris, Flight adaptations in Birds and Aerial adaptations in Bat) 05 Marks

Q.6. Class Records 05 Marks

II SEMESTER ZOOLOGY

2.7:-PAPER II - COMPARATIVE ANATOMY AND DEVELOPMENTAL BIOLOGY OF VERTEBRATES

CREDITS 4 - 60 Hours

Unit I: Integumentary System **04 hrs.**

1.1 Integument and its modifications in the chordates- epidermal derivatives and dermal derivatives- with reference to glands and digital tips. 02 hrs.

1.2 Comparison of integument in Vertebrate series- Pisces (Shark), Amphibia (Frog), Reptiles (Lizard), Aves (Pigeon) and Mammals (Rabbit). 02 hrs.

Unit II: Skeletal System **03hrs.**

2.1 Trace the evolution of visceral arches in the Vertebrate series. 01hrs.

2.2 Comparative account of the Pectoral and Pelvic girdle of Amniotes (Amphibian, Bird and Mammal). 02 hrs.

Unit III: Digestive System **04hrs.**

3.1 Comparative account of the digestive glands in different Vertebrates. 01hrs.

3.2 Comparative account of the alimentary canal in Vertebrate series. 03 hrs.

Unit IV: Respiratory System

4.1 Evolutionary trends in the Respiratory system with reference to modification of gills, lungs, air sacs and swim bladder. 0**4 hrs.**

Unit V: Circulatory System

5.1 Evolutionary trends in the heart and aortic arches in Vertebrate series. 0**4 hrs.**

Unit VI: Urinogenital System

6.1 Succession of kidney, Evolution of urinogenital duct in vertebrates. 0**4 hrs.**

Unit VII: Nervous System

7.1 Comparative account of brain of Shark, Frog, Lizard, Pigeon and Rabbit. 0**3 hrs.**

Unit VIII: Sense Organs **03 hrs.**

8.1 Types of receptors in Vertebrates 01 hr.

8.2 Trace the development of membranous labyrinth in Pisces and Amphibians. 01 hr.

8.3 Evolution of ear ossicles in the Mammals. 01 hr.

Unit IX: Early Embryonic Development **12 hrs.**

9.1 Gametogenesis: Spermatogenesis and Oogenesis with reference to mammals 02 hrs.

9.2 Vitellogenesis in birds 01 hrs.

9.3 Fertilization – External fertilization (Amphibians), Internal fertilization (Mammals) 02 hrs.

9.4 Early development of Frog and Chick; - Structure of mature egg and its membranes. 01hrs.

9.5 Patterns of cleavage, fate map of Frog and Chick. 02 hrs.

9.6 Comparative account of Blastula in Frog and Chick. 01 hrs.

9.7 Gastrulation in Frog and Chick. 02 hrs.

9.8 Neurulation in Frog embryo. 01 hr.

Unit X: Late Embryonic Development **10 hrs.**

10.1 Implantation of embryo in Humans. 01 hr.

10.2 Formation of Human placenta and functions. 02 hrs.

10.3 Basic types of placenta- yolk sac placenta, allantois placenta; deciduate and non deciduate. Types of placenta on the basis of Histology; Hormonal control of Implantation. 04 hrs.

10.4 Metamorphic events in Frog life cycle. Hormonal control of Amphibian metamorphosis. 03 hrs.

Unit XI: Control of Development **09 hrs.**

Fundamental processes in development - Gene activation, determination, induction, Differentiation, morphogenesis.

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.
- Hildebrand, 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.

II SEMESTER PRACTICAL-II (2.8)

BASED ON COMPARATIVE ANATOMY AND DEVELOPMENTAL BIOLOGY OF VERTEBRATES

(CREDITS 2)

1. Osteology: **04 Units**

(a) Skeleton of [Fowl/Pigeon (Bird)] and [Rabbit/Rat (Mammal)].
(b) Carapace and Plastron of Tortoise/ Turtle.
(c) Mammalian Skull:
Herbivorous (Rabbit/ Horse) and Carnivorous (Dog/Cat)

2. Developmental Biology (slides) **02 Units**

Permanent slides Frog: Cleavage, Blastula, Gastrula, Neurula, tail bud stage, tadpole external gill stage, tadpole internal gill stages.

3. Histology:

Permanent Slides of Placenta**:** **01 Unit**

(a) Epithelio-Chorial placenta
(b) Syndesmo- Chorial placenta
(c) Endothelio- Chorial placenta
(d) Haemo- Chorial placenta
(e) Haemo-endothelial placenta

4. Museum specimens of Vertebrate embryos /slides of different stages of Chick Embryo (18 hrs, 24 hrs, 36 hrs, 48 hrs and 72 hrs whole mount stages) **01 Unit**

5. Whole mount preparations: Fish scales – Placoid/ Ctenoid/Cycloid Scales **02 Units**

II SEMESTER ZOOLOGY

PRACTICAL –II (2.8) BASED ON COMPARATIVE ANATOMY AND DEVELOPMENTAL BIOLOGY OF VERTEBRATES

SCHEME OF EXAMINATION

Duration: 3 hrs. **Max. Marks: 50**

Q 1. COMPARATIVE ANATOMY

a. Compare and Comment on – Skeleton of Bird and Mammal (any one bone each from I - a). 08 marks

b. Osteology: (from I-b & c any two). (5×2)=10 marks

Q II. DEVELOPMENTAL BIOLOGY

Identifications: 4 Slides

(Frog 2 Slides; - Placenta 2 Slides from 2 & 3). **(**4×3)=12 marks

Spotters: (Any two embryos of Vertebrates/Permanent slides any two- from 4).

(2×3)=06marks

Q III. WHOLE MOUNT PREPARATION (Any one). 04 marks

Q IV. VIVA - VOCE (Concern to practical syllabus). 05 marks

Q V. CLASS RECORDS. 05 marks

(Note: Charts, Photo graphs and Models can be shown)

III SEMESTER ZOOLOGY

3.7:-PAPER III - PHYSIOLOGY AND BIOCHEMISTRY

CREDITS 4 - 60 Hours

Unit 1: Nerve and Muscle **08hrs**

Structure of neuron, resting membrane potential, Graded potential, Origin of Action potential and its propagation in myelinated and non-myelinated fibers.

Ultra-structure of skeletal muscle, Chemical composition, Physicochemical changes during muscle contraction, Sliding filament theory

Unit 2: Digestion **05hrs**

Control of digestive secretions, Physiology of Absorption of carbohydrates, proteins, lipids
Common gastrointestinal disorder in man -Ulcer, Cirrhosis, Hepatitis and Endoscopy.

Unit 3: Respiration **05hrs**

Pulmonary ventilation, Vital capacity and respiratory volumes, Transport of oxygen and carbon dioxide in blood. Disorders-Carbon monoxide poisoning and Silicosis.

Unit 4: Excretion **06hrs**

Structure of nephron, mechanism of urine formation, counter-current mechanism, Nephritis and Dialysis.

Unit 5: Cardiovascular system **07hrs**

Composition of blood, Hemostasis, Origin and conduction of the cardiac impulse,
Cardiac cycle, Disorders-Thrombosis, Anemia, Leukemia.

Unit 6: Reproduction and Endocrine glands **08hrs**

Male reproductive system (Human), hormonal control of spermatogenesis, Female reproductive system (Human), hormonal control of menstrual cycle.
Microscopic structure and function of pituitary, thyroid, pancreas and adrenal.

Unit 7: Carbohydrate Metabolism **08hrs**

Glycolysis: EMP pathway, fate of pyruvic acid in yeast, muscle and lactic acid bacteria Krebs cycle,
Pentose phosphate pathway: Oxidative and non-oxidative phase
Gluconeogenesis; Path way, regulation and significance
Glycogen metabolism: Glycogenolysis, glycogenesis
Regulation of blood sugar level (Homeostasis), Diabetes mellitus

Unit 8: Lipid metabolism **04hrs**

Biosynthesis and beta oxidation of palmitic acid

Unit 9: Protein metabolism **04hrs**

Transamination, Deamination and Urea cycle.
Disorders of Amino acid metabolism-PKU, AKU

Unit 10: Enzymes **05hrs**

Introduction, Mechanism of action- lock and key hypothesis, induce fit hypothesis
Enzyme kinetics- Effect on enzyme concentration, substrate concentration, PH, temperature and on velocity of enzyme catalyzed reaction.
Inhibition- non-competitive and competitive
Regulation- Allosteric or end product (ex-phosphofructo kinase)

SUGGESTED READING

- Tortora, G.J.and Derrickson, B.H. (2009). **Principles of Anatomy and Physiology**, XII Edition, john Wiley &Sons, Inc.
- Widmaier,E.P.,Raff H.andStrang,K.T.(2008) **Vander's Human physiology** XI Edition. McGraw Hill
- Guyton, A.C.and Hall, J.E (2011) **Text book 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.Lehninger, A.L (2009).**Principles of Biochemistry**.IV Edition. W.H Freeman and Co.
- Murray,R.K.,Granner,D.K.,Mayes,P.Aand Rodwell, V.W.(2009) **Harper's lustrated Biochemistry**. XXVIII Edition. Lange Medical Book/Mc Mraw3Hill

III SEMESTER PRACTICAL-III (3.8)

BASED ON PHYSIOLOGY AND BIOCHEMISTRY

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.

III SEMESTER ZOOLOGY

PRACTICAL –III (3.8) BASED ON PHYSIOLOGY AND BIOCHEMISTRY

SCHEME OF EXAMINATION

Duration: 3 hrs. **Max. Marks:50**

Q 1.Biochemistry experiment	15 marks
Q 2.Histology (2+3=5slides)	(5X5) =25marks
Q 3.Record	05marks
Q 4.Viva (Histological sections)	05marks

IV SEMESTER ZOOLOGY

4.7:-PAPER IV - INSECT, VECTORS AND DISEASES

CREDITS- 4, 60 Hours

Unit I: Introduction to Insects **06hrs**

Introduction to Entomology, morphology of Head and Eyes of insects, Types of antennae, trophi of insects Cockroach, Mosquito (male and female), Housefly, Honeybee and Butterfly with reference to feeding habits.

Unit II: Concept of Vectors **06hrs**

Brief introduction of Carrier and Vectors (mechanical and biological vector), Reservoirs, Host-vector relationship, Adaptations of vectors, Host Specificity.

Unit III: Insects as Vectors **08hrs**

General characters and classification of insects up to orders, detailed features of insects, orders as vectors-Diptera, Siphonaptera, Siphunculata, Hemiptera.

Unit IV: Dipteran as Disease Vectors **24hrs**

Dipterans as important insect vectors-Mosquitoes, Sand fly, Houseflies.

Study of mosquito-borne diseases-Malaria, Dengue, Chikungunya, Viral encephalitis, Filariasis; Control of mosquitoes.

Sand fly-borne diseases - Visceral Leishmaniasis, Cutaneous Leishmaniasis, Phlebotomus fever, Control of Sand fly.

Study of house fly as important mechanical vector and Control of house fly.

Unit IV: Siphonaptera as Disease Vectors **06hrs**

Fleas as important insect vectors: Host-specificity, Study of Flea-borne diseases - Plague, Typhus fever, Control of fleas.

Unit V: Siphunculata as Disease Vectors **04hrs**

Human louse (Head and Body 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 **06hrs**

Bugs as insect vectors: Blood-sucking bugs, Chagas disease, Bed bugs as mechanical vectors, Control and prevention measures.

SUGGESTED READINGS:

- Imms, A.D. (1977). A General Text Book of Entomology. Champan & Hall, UK.
- Chapman, R.R (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.

IV SEMESTER PRACTICAL-IV (4.8)

BASED ON INSECT, VECTORS AND DISEASES

CREDITS -2

1. Study of different kinds of mouth parts of insects (Cockroach, Mosquito (male and female), Housefly, Honeybee and Butterfly).

2. Study of following insect vectors through permanent slides /photographs:
   Aedes, Culex, Anopheles, Pediculus humanus capitis. Pediculus humanus corporis, Phithirus 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

IV SEMESTER ZOOLOGY

PRACTICAL –IV (4.8) BASED ON INSECT, VECTORS AND DISEASES

SCHEME OF EXAMINATION

Duration: 3 hrs. **Max. Marks: 50**

Q 1. Identify and comment on A and B	
(Two insects mouth parts (trophi)-slides/photograph	(2x5) = 10 marks
Q 2. Identify, Classify, Comment and diseases transmitted by	
Insect vectors any four	(4x5) = 20 marks
Q 3. Submission of project report on Insect vectors and Diseases	
transmission	10 marks
Q 4 Viva voce (based on complete practical)	05 marks
Q 5 Practical records	05 marks

IV SEMESTER ZOOLOGY

4.9- OPEN ELECTIVE PAPER

APICULTURE

(CREDITS 2)

Unit 1: Biology of Bees **04hrs**

History, Classification and Biology of Honey Bees
Social Organization of Bee Colony

Unit 2: Rearing of Bees **10hrs**

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)

Unit 3: Diseases and Enemies **05hrs**

Bee Diseases and Enemies
Control and Preventive measures

Unit 4: Bee Economy **02hrs**

Products of Apiculture Industry and its Uses (Honey, Bee wax).

Unit 5: Entrepreneurship in Apiculture **04hrs**

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.
- Singh S: *Beekeeping in India*, Indian council of Agriculture Research, New Delhi.

V SEMESTER ZOOLOGY

5.7:-PAPER V - GENETICS AND EVOLUTIONARY BIOLOGY

CREDITS- 3, 45 Hours

Unit 1: Introduction to genetics **02hrs**

Mendel's work on transmission of traits, Genetic variation, Molecular basis of genetic information.

Unit 2: Mendelian Genetics and its Extension **08hrs**

Principles of inheritance, Chromosome theory of inheritance,
Incomplete dominance and co-dominance,
Multiple alleles-ABO and Rh alleles, Rh incompatibility in humans.
Lethal alleles, Pleiotropy,
Epistasis-Dominant and recessive,
Sex-linked inheritance-Eye colour in Drosophila, Haemophilia, Colour blindness in Man.
Extra-chromosomal inheritance.

Unit 3: Linkage, Crossing over and Chromosomal Mapping **04hrs**

Linkage and crossing over, Chromosomal mapping, Somatic cell genetics and its applications.

Unit 4: Mutations **05hrs**

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

Unit 5: Sex Determination **04hrs**

Chromosomal mechanisms-XX-OX, XX-XY, ZZ-ZW type, genic balance theory of Bridges
Dosage compensation in Man

Unit 6: History of life **03hrs**

Major events in History of life: Geological Time Chart-Environmental conditions-Dominant Fauna and implications.

Unit 7: Introduction to Evolutionary Theories **04hrs**

Lamarckism, Darwinism, Neo-Darwinism

Unit 8: Direct Evidences of Evolution **04hrs**

Types of fossils, dating of fossils (Carbon-14, Potassium-Argon, Uranium-Lead method),

Phylogeny of Horse

Unit 9: Processes of Evolutionary Change **04hrs**

Organic variations: Isolating Mechanism, Natural selection (Examples: Industrial melanism) Artificial selection

Unit 10: Species Concept **02hrs**

Species concept (Advantages and limitations)
Modes of speciation (Allopatric, Sympatric)

Unit 11: Macro- Evolution **02hrs**

Macro Evolutionary Principles (example: Darwin's Finches)

Unit 12: Extinction **03hrs**

Mass extinction (Causes, Names of five major extinctions-K-T extinction in brief)
Role of extinction in evolution.

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** Edition. John Wiley and sons Inc.
- Klug,W.S.,Cumming,M.R., Spencer,C.A.(2012).**Concepts of Genetics** X Edition. Benjamin Cummings.
- Russell, P.J. (2009) **Genetics-A Molecular Approach**.III Edition. Benjamin Cumming.
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- Organic Evolution by Veer Bala Rastogi
- Human Genetics by Mange and Manage
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- Genetics by P.K.Gupta.
- Genetics by Veer BAL Rastogi.

V SEMESTER ZOOLOGY

5.8:-PAPER VI - CELL BIOLOGY, IMMUNOLOGY AND BIOTECHNOLOGY

CREDITS- 3, 45 Hours

Unit 1 **03hrs**

Microscopy: Principles of Light microscope, Magnification and Resolving power, Phase contrast microscope, Electron microscope.
Centrifuge: Principles, Structure of centrifuge and applications of centrifugation.

Unit: 2 **05hrs**

Plasma membrane: Fluid mosaic model (Singer and Nicholson 1972), Chemical composition of plasma membrane.
Cell-Cell interactions: Microvilli, Tight junctions, Desmosomes and Gap junctions.
Functions of Plasma membrane: Exocytosis, Endocytosis, Phagocytosis and Pinocytosis.
Cell organelles: Structure and functions of Centrosome, Mitochondrion, Golgi complex and Nucleus.

Unit 3 **02hrs**

Giant chromosomes: Polytene chromosome, Lamp brush chromosome and Super numerary chromosomes.

Unit 4 **02hrs**

Parthenogenesis: Natural Parthenogenesis, artificial parthenogenesis and significances.

Unit 5 **01hrs**

Aging: Causes of aging, changes occurring during aging and Telomere and aging.

Unit 6 **01hrs**

Stem cells: Types, Properties of stem cells, embryonic stem cells culture and applications of stem cells.

Unit 7 **04hrs**

Biology of Cancer: Introduction, Malignant and Non-malignant tumour, Metastasis, Carcinogen, General properties of cancerous cells, Structural and Metabolic variations of cancerous cells, Symptoms of cancer, Treatment: Surgical, Chemotherapy and Gene therapy. Preventive measures of cancer.

IMMUNOLOGY:

Unit 1 **01hrs**

Introduction to Immunology. Applications of immunology in Medicine, Microbiology, Blood group typing and Tissue organ transplantation.

Unit 2 **01hrs**

Cells involved in Immune response: Lymphocytes, T lymphocyte, B lymphocyte, NK cell, K cell, Macrophage, Dendritic cells, Eosinophil, Basophil, Neutrophil, Antigen presenting cell and Mast cell.

Unit 3 **02hrs**

Antigens: Structure and function of Antigen, types of antigens, exogenous, endogenous, Thymus independent and Thymus dependent antigen.

Unit 4 **01hrs**

Immunity: Innate immunity and Acquired immunity.

Unit 5 **02hrs**

Immune response: Antibody mediated immune response and Cell mediated Immune response.

Unit 6 **02hrs**

Lymphoid organs: Primary lymphoid organs (Thymus, Bursa fabricus in birds, Bone marrow in mammals). Secondary lymphoid organs (Lymph node, Spleen and Tonsils).

Unit 7 **02hrs**

AIDS: Introduction, Immunological basis of HIV, Mode of infection, preventive measures and HIV test ELISA.

Unit 8 **01hrs**

Production of Monoclonal antibodies and applications. Polyclonal antibodies.

Unit 9 **02hrs**

Transplantation and Plastic surgery: Transplantation, Types of Graft, Brief account of organ transplantation (Kidney, Heart, Liver, Pancreas, Lung, Skin graft and Bone marrow transplants). Immunosuppressors, Cornea grafting. Plastic surgery (Cosmetic and Reconstructive surgery)

ANIMAL BIOTECHNOLOGY:

Unit: 1 **01hrs**

Introduction to Animal Biotechnology
Biotechnology and its branches, scope of Biotechnology.

Unit: 2 **04hrs**

Genetic Engineering: Isolation of desired gene, cloning vector (Plasmid), cloning enzyme Restriction endonucleases, DNA ligase, Construction of rDNA, Transformation of Host cell, Mass culture in bioreactor, downstream processing.
Brief account of Genomic library and c- DNA library.
Bimolecular methods: Gel electrophoresis, Extraction of DNA from Agarose Gel (Free squeeze method and Low temperature melting method) Restriction digestion of DNA.

Unit: 3 **02hrs**

Blotting techniques: Southern, Northern, Western blotting techniques with their applications.

Unit: 4 **03hrs**

Transgenic animals: Nuclear transplantation method (Dolly), Micro injection method (Mice) Embryonic stem cell transplantation (Chimeric mice)

Unit: 5 **03hrs**

Assisted reproductive Technology: Cryopreservation of semen, AI, GIFT, IVF and ET Techniques.

References:

Cell biology by: C.B. Power vol and 2
Cell biology by: Tomer.
Cell biology by: Satyesh Chandra Roy and Kalyan Kumar D.E.
Biotechnology: by V.Kumaresan.
Immunology: by Dulsy Fathima and N. Arumugam
Immunology: by Seemi Farhat Basir
Biotechnology: by R.C.Dubey

V SEMESTER PRACTICAL-V (5.9A)

BASED ON GENETICS AND EVOLUTIONARY BIOLOGY

CREDITS -2

1. Study of -Mendelian Inheritance (Mono and Dihybrid crosses) - 4 problems each

   Gene interactions (Blood groups, Sex linked inheritance) 4 problems each

2. Buccal smear preparation for sex chromatin

3. Study of Human Karyotypes (normal) and abnormal- (Turner's, Klinefelter's, Down; s and Cri-du-chat syndrome)

4. Study of fossil evidences from plaster cast models and pictures.

   (Trilobite, Archaeopteryx, Brontosaurus, Stegosaurus, Plesiosaurus and Woolly mammoth)

5. Study of homology and analogy from suitable specimens /pictures

6. Charts:

   a) Phylogeny of Horse with diagrams/cut out of limbs and teeth of Horse ancestors

   b) Darwin's finches with diagrams/cut out of beaks of different species

7. Submission of report on-Evolution of Horse

   Evolution of Camel

   Evolution of Elephant

   Evolution of Man

V SEMESTER PRACTICAL-V (5.9A)

BASED ON GENETICS AND EVOLUTIONARY BIOLOGY

SCHEME OF EXAMINATION

DURATION: 3 HOURS **MAX.MARKS:50**

Q 1.Problem on (Mono, Dihybrid, blood group, sex-linked inheritance) 05marks

Q 2. Buccal smear preparation for sex chromatin 07marks

Q 3. Identify and comment-Human Karyotypes (normal and abnormal) (5x2) =10marks

Q 4.Identify and comment- fossil evidences from plaster cast models and pictures (Homologous and Analogous organs) (3x2) =06marks

Q 5.Identify and comment- Phylogeny of Horse / limbs and teeth of Horse ancestors.06marks

Q 6.Identify and comment- Darwin's finches / beaks of different species 06marks

Q 7.Submission of report 05marks

Q 8.Class record 05marks

V SEMESTER PRACTICAL-VI (5.9B)

BASED ON CELL BIOLOGY, IMMUNOLOGY AND BIOTECHNOLOGY

CREDITS -2, 15 Units

1) Cell biology: Preparation of squash of the given material Grasshopper for meiosis and Onion root tips for mitosis **4Units**

(Procedure to be written for squash preparation, Identification and comment on any one of the observed cell stage)

2) Mounting of Salivary gland chromosome (Drosophila or Chironomous larva) **2Units**

3) Study of Cell organelle:

Centrosome, Golgi complex, Nucleus and Endoplasmic reticulum **2 Units**

(Photograph or Chart)

4) Immunology: **4 Units**

1) Study of Blood cells of human being

2) Study of lymphoid organs: Thymus, spleen, Tonsil and lymph node and 2 Slides /Photograph)

5) Biotechnology: **3 Units**

1) Isolation of Liver parenchyma cells.

2) Gram positive staining and identification of E.coli

V SEMESTER PRACTICAL-VI (5.9B)

BASED ON CELL BIOLOGY, IMMUNOLOGY AND BIOTECHNOLOGY

Scheme of Practical examination

Duration 3 Hours **Max Marks: 50**

1) Cell biology: **10 marks**

Preparation of squash of the given material Grasshopper testes for meiosis or Onion root tips for mitosis

(Procedure to be written for squash preparation, Identification and comment on observed cell stage)

2) Study of Cell organelle any TWO (Photograph or Chart) **(2X5) =10 Marks**

3) Immunology: Study of blood cells **05 Marks**

Lymphoid organ (any one) **05 Marks**

4) Biotechnology any one of the experiments 1 or 2 **10 Marks**

5) Viva related to practical (Meiosis, Mitosis and Human blood cells) **05 Marks**

6) Class records **05 Marks**

VI SEMESTER ZOOLOGY

6.7:-PAPER VII - APPLIED ZOOLOGY

CREDITS- 3, 45 Hour

Unit 1: Introduction to Host-parasite Relationship **03hrs**

Host, Definitive host, Intermediate host, Parasitism, Symbiosis, Commensalism, Reservoir, Zoonosis

Unit 2: Epidemiology of Diseases **05hrs**

Transmission, Prevention and control of diseases: Tuberculosis, typhoid

Unit 3: Rickettsia and Spirochaetes **06hrs**

Brief account of *Rickettsia prowazekii, Borrelia recurrentis* and *Treponema pallidum*

Unit 4: Parasitic Protozoa **06hrs**

Life history and pathogenicity of *Entamoeba histolytica, Plasmodium vivax* and *Trypanosoma gambiense*

Unit 5: Parasitic Helminthes **05hrs**

Life history and pathogenicity of *Ancylostoma duodenale* and *Wuchereria bancrofti*

Unit 6: Insects of Economic Importance **06hrs**

Biology, Control and damage caused by *Helicoverpa armigera, Pyrilla perpusilla* and *Papilio demoleus,, Sitophilus oryzae* and *Tribolium castaneum*

Unit 7: Animal Husbandry **05hrs**

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

Unit 8: Poultry Farming **05hrs**

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

Unit 9: Fish Technology **04hrs**

Induced breeding preservation and processing and transportation of fishes

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). A g r i c u l t u r a l 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 & Fibiger Publisher
- Dunham R.A. (2004). *Aquaculture and Fisheries Biotechnology Genetic Approache*s. CABI publications, U.K.
- Pedigo, L.P. (2002). *Entomology and Pest Management*, Prentice Hall.

VI SEMESTER ZOOLOGY

6.8:-PAPER VIII - ENVIRONMENTAL BIOLOGY AND ETHOLOGY

CREDITS- 3, 45 Hours

Unit 1 **02hrs**

Fundamentals of Ecology

Introduction to Ecology, Sub division of Ecology- Autoecology, Synecology
Scope of Ecology.
Concept of Habitat, Micro habitat, Macro habitat with appropriate examples.
Concept of Ecological niche, Habitat [Spatial] niche, Tropical niche, Hyper volume [Multi-dimensional niche]

Unit II **04hrs**

Abiotic factors

Temperature: Thermal stratification, Range of tolerance, Piokilothermy and Homeothermy.
Light: Distribution, Ecological effects, Photoperiodism and Bioluminescence.
Water: Structure of water, Sources of water, Classification of animals on the basis of water requirement-Hydrocoles, Xerocoles and Mesocoles. Properties of water.
Liebig's Law of Minimum and Shelford's Law of Tolerance.

Unit III **04hrs**

Ecosystem

Structure and function of Pond and Estuarine ecosystem.
Concept of Productivity, Energy flow, Laws of Thermodynamics.
Food chain, Food web, Ecological pyramids and its Significances.

Unit IV **03hrs**

Animal relationships

Mutualism, Proto-cooperation and Commensalism.
Antibiosis, Parasitism, Predation and Competition.
Competitive exclusion principle [Gause's principle].

Unit VI **03hrs**

Animal Adaptations

Deep sea adaptation in Fish.
Aerial adaptation in Insects.
Desert adaptation in Camel.

Unit VII **02hrs**

Population Ecology

Density, Natality, Mortality, Age distribution, Population growth, Dispersal and Biotic potential

Theories on population- Malthusian theory and Marxian theory.

Unit VIII **04hrs**

Environmental pollution

Pollutants, Types of pollutants, Air and Water pollution [Causes, Ecological effects and Control measures]

Solid waste management, Sources, Types, Effects of solid waste. Management of solid waste.

Unit IX **03hrs**

Toxicology

Introduction, Scope and Basic divisions of Toxicology.

Toxicants, Classification of toxicants [Microbial and animal toxin].

Toxicity, Lethal concentration LC-50.

Toxic effects of heavy metals Lead and Mercury on Human health.

Unit X **03hrs**

Current Environmental issues

Ozone layer depletion, Causes, Effects and Control measures.

Greenhouse effect and Greenhouse gases, Causes, Effects and Control measures.

Acid rain, causes effects and control measures.

Unit XI **03hrs**

Wild life conservation and Management

Wild life, Aims of wild life conservation, Necessity for conservation, Causes for wild life depletion, Threatened species, endangered species, Red data book. Major wild life Sanctuaries and National parks of India, Biosphere reserves.

Major organization involved in wild life conservation.

Unit XII **02hrs**

Indian laws on Environment

Environmental protection act 1986, Wild life protection act 1972.

ETHOLOGY **12hrs**

Unit 1 **02hrs**

Introduction to Ethology, Branches of Ethology
Historical contributions.
Aims and Objectives.

Unit II **02hrs**

Stereotyped behaviour/Innate behaviour
Kinesis, Taxes, Reflexes, Instincts with suitable example.

Unit III **02hrs**

Acquired behaviour/Learning behaviour
Imprinting, Habituation and Trail and error and learning with suitable example.

Unit IV **03hrs**

Animal Communication
Light, Odour, Signal and Sound with suitable example.

Unit V **03hrs**

Social organization in Animals
Termites and Primates (Monkey).

References

1] Fundamentals of Ecology by Eugene. P. Odum

2] Essential Environment by Dr M.K. Goyal.

3] Toxicology by P.D. Sharma.

4] Introduction to Animal behaviour by Manning and M.S. Dawkins

6] Animal Behaviour by Reena Mathur.

VI SEMESTER PRACTICAL-VII (6.9A)

BASED ON APPLIED ZOOLOGY

APPLIED ZOOLOGY

CREDITS 2

Unit I: Study of *Plasmodium vivax, Entamoeba histolytica, Trypanosoma gambiense,*

Unit II: *Ancylostoma duodenale* and *Wuchereria bancrofti* and their life stages through permanent slides/photomicrographs or specimens.

Unit III: Identifying feature and economic importance of Helicoverpa *(Heliothis*) *armigera, Papilio demoleus*.

Unit IV: Identifying features of *Pyrilla perpusilla, Callosobruchus chinensis, Sitophilus oryzae* and *Tribolium castaneum*

Unit VI: Maintenance of freshwater aquarium

Unit VI: Submission of project report on poultry farm or animal breeding centre.

VI SEMESTER PRACTICAL-VII (6.9A)

BASED ON APPLIED ZOOLOGY

APPLIED ZOOLOGY

Scheme of Practical Examination

Duration 3 Hours **Max Marks: 50**

Q 1. Identification of parasites (any six) **(6x4) = 24 marks**
(3 from Unit I and II, 3 from Unit III and IV)

Q 2. Question an Aquarium ecosystem. **10 marks**

Q 3. Project report submission. **06 marks**

Q 4. Viva (based on practicals). **05 marks**

Q 5. Class record. **05 marks**

VI SEMESTER PRACTICAL-VIII (6.9B)

BASED ON ENVIRONMENTAL BIOLOGY AND ETHOLOGY

CREDITS- 2, 15 Units

1) Environmental Biology Experiments: **4 Units**

Estimation of A] Dissolved Oxygen B] Dissolved Organic Matter

C] Salinity D] Hardness E] Alkalinity F] pH

Note:

- Any 5 Experiments to be performed.
- A to F by Titrimetric method.
- pH, using pH-meter, pH paper.

2) Ecological adaptations [Taxonomy, diagram and comment] **5 Units**

- A] Tubiculous worms: Arenicola, Chaetopterus.
- B] Burrowing forms: Dentalium, Balanoglossus and Amphioxus.
- C] Sedentary forms: Sea anemone, Ascidia.
- D] Passive flight adaptation: Exoceteus, Draco and Rhacophours.
- E] Animal association: Colonial forms: Physalia, Honey bees and Termites.
- F] Parasitism: Tapeworm, Sacculina on Crab.
- H] Mimicry Camouflage: Stick insect, Chameleon.
- I] Desert form: Pharynosoma, Camel [Picture or Photograph].

3) Identification of Endangered Species. **2 Units**

Taxonomy, diagram and comment. (Any four of the following)
1] Red Panda 2] One horned Rhinoceros 3] Ridely Turtle 4] Monitor Lizard
5] Great Indian Hornbill 6) Salim Ali's Fruit bat.

4) Ethology: **2 Units**

A) Study of Chaemotaxis in third larvae of Drosophila melanogaster to odours. [Fructose, Yeast and Ethyl acetate]

B) Study of Chaemotaxis in third instar larvae of Drosophila melanogaster at different concentration of Ethyl acetate

5) Submission of Project report: **2 Units**

1) Rain water harvesting 2) Migration in Salmon and Eel.
3) Visit to Zoo/Sanctuary/ National park (Study tour).
4) Project on Endangered species.
5) Social Organization in Primates.
6) Eco-behavioural adaptations: Deep Sea fishes, Bioluminescence in fishes or any other animal. Adaptations in Birds, any of the Desert fauna, or any of the Mammalian fauna.

VI SEMESTER PRACTICAL-VIII (6.9B)

BASED ON ENVIRONMENTAL BIOLOGY AND ETHOLOGY

Scheme of Practical Examination

Duration 3 Hours **Max Marks: 50**

Q 1) Environmental Biology Experiments

Any one of the Estimations from A to F **14 marks**

Q 2) Ecological adaptations: [Taxonomy, Diagram and Comment]

(4 Specimens x 4)= 16marks

Q 3) Identification of Endangered species [Taxonomy, Diagram and Comment]

Any one of the endangered species **05 marks**

Q 4) Ethology (One experiment) **05 marks**

Q 5) Submission of Project report **05 marks**

Q 6) Class records **05 marks**

Question Paper Format
For
B.Sc., Course (CBCS) in Zoology of Tumkur University, Tumakuru
B.Sc., I-VI Semester Examination in Zoology

Time Duration: 03 Hours. **Total Marks: 90 marks.**

(Draw neat labelled diagrams wherever necessary)

I. Answer any Ten from the following: **(10x02=20 marks)**

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.
11.
12.

II. Answer any Six from the following: **(06x05=30 marks)**

13.
14.
15.
16.
17.
18.
19.
20.

III. Answer any Four from the following: **(04x10=40 marks)**

21.
22.
23.
24.
25.
26.

Question Paper Format
For
B.Sc., Course (CBCS) in Zoology of Tumkur University, Tumakuru
B.Sc., I-VI Semester Internal Test in Zoology

Time Duration: 01 Hour. **Total Marks: 45 marks.**

(Draw neat labelled diagrams wherever necessary)

I. Answer any Five from the following: **(05x02=10 marks)**

1.
2.
3.
4.
5.
6.
7.

II. Answer any Three from the following: **(03x05=15 marks)**

8.
9.
10.
11.
12.

III. Answer any Two from the following: **(02x10=20 marks)**

13.
14.
15.
16.

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