MANIPUR UNIVERSITY

UG COURSE IN ZOOLOGY (NEW)

FIRST YEAR (SEMESTER I & II)

(As per Manipur University Ordinance for Four Year Undergraduate Program 2025 based on NEP – 2020)

For implementation from the year 2025

MANIPUR UNIVERSITY
UG COURSE IN ZOOLOGY
Course Structure (NEW)

(As per Manipur University Ordinance for Four Year Undergraduate Program 2025 based on NEP – 2020)

1.1 Credit distribution for the course

Semester	Course Opted	Course code	Name	Credit
I	Ability Enhancement Course	**AEC45Z00101(T)25**	Communication Skills	4
	Major-I	**MJC45ZOO101(T)25**	Animalia, Non-chordates: Protozoa to Echinodermata, Minor Phyla	3
	Major -I Practical	**MJC45ZOO101(P)25**	,,	1
	Minor-I	**MNC45ZOO101(T)25**	Fundamentals of Zoology-1 : Non Chordates	3
	Minor-I Practical	**MNC45ZOO101(P)25**	,,	1
	Multidisciplinary Course - 1	**MDC45ZOO101(T)25**	Introduction to Animal diversity - 1	3
	Skill Enhancement Course (SEC)- I	**SEC45ZOO101(T)25**	Aquarium Fish keeping **or** Apiculture **or** Poultry farming	2
	Skill Enhancement Course (SEC)- I Practical	**SEC45ZOO101(P)25**	Aquarium Fish keeping **or** Apiculture **or** Poultry farming	1
	Value added Course (VAC) - I	**VAC45ZOO101(T)25**	As per College preference e.g. NCC/NSS/Solid Waste management/IPR	2
				20
II	Ability Enhancement Course	**AEC45Z00102(T)25**	Academic Writing	4
	Major-2	**MJC45ZOO102(T)25**	Chordates : General organization – Hemichordata to Mammalia	3
	Major-2 Practical	**MJC45ZOO102(P)25**	,,	1
	Minor-2	**MNC45ZOO102(T)25**	Fundamentals of Zoology-2 : Chordates	3
	Minor-2 Practical	**MNC45ZOO102(P)25**	,,	1
	Multidisciplinary Course - 2	**MDC45ZOO102(T)25**	Introduction to Animal diversity - 2	3

	Skill Enhancement Course (SEC)- II	**SEC45ZOO102(T)25**	Sericulture **or** Vermicomposting **or** Organic farming **or** Fish Farming	2
	Skill Enhancement Course (SEC)- II Practical	**SEC45ZOO102(P)25**	Sericulture **or** Vermicomposting **or** Organic farming **or** Fish Farming	1
	Value added Course (VAC) - 2	**VAC45ZOO102(T)25**	As per College preference e.g. NCC/NSS/Solid Waste management/IPR	2
				20
Summer Internship in a Research laboratory or a Government Institute outside the College in an area of Zoology. This must be taken up during summer vacation in the first year (i.e. during Semester I and II)				**4**
Exit option with Bachelor's Certificate in Zoology on completion of Courses equal to a minimum of 44 Credits including the Credits for the work-based summer internship.				

N.B.*: Students can earn upto 40 % of the total Credits of a given Semester through online learning Courses offered via SWAYAM or any other platform recognized by the UGC, provided they need to declare their chosen Courses before the semester begins. Only equivalent Credits or those exceeding the Credit allocation in Multidisciplinary Courses (MDC), Ability Enhancement Courses (AEC), Skill Enhancement Courses (SEC) and Value-added Courses (VAC) may be selected.*

For Zoology Students, Multi-disciplinary Course can be selected from other Subjects. Multi-disciplinary Course " Introduction to Animal diversity" must be offered by Students of subjects other than Zoology.

Major -I: MJC45**ZOO101(T)25**

(Animalia, Non-Chordates : Protozoa to Echinodermata, Minor Phyla)

Objective:

The course is aimed with the objective of providing knowledge of the diversity of animal life especially among the non Chordates. It shall provide an insight to the learner about the existence of different life forms on the Earth, and appreciate the diversity of animal life. It will help the student to understand the features of Kingdom Animalia and systematic organization of the animals based on their evolutionary relationships, structural and functional affinities. Morphological and anatomical features of diverse animal groups; their significance and their relationships have been incorporated to create interest among the students to explore the animal diversity in nature. The course will also make the students aware about the characteristic morphological and anatomical features of diverse animals; economic, ecological and medical significance of various animals in human life; and will create interest among them to explore the animal diversity in nature.

Outcome:

The outcome expected on completion of Course:

- Having knowledge of systematic position, habitat and structural organization of non-chordates.
- Understand the economic importance of non-chordates, their interaction with the environment, role in the ecosystem, evolutionary history and their relationships.
- Having enhanced knowledge of the said group and communication skills through practical sessions, group discussions, assignments and projects.
- Appreciate the diversity of non-chordates living in diverse habit and habitats.
- Understand evolutionary history and relationships of different non-chordates through functional and structural affinities.
- Critically think about the organization, complexity and characteristic features of non-chordates.
- Getting familiarized with the morphology and anatomy of representatives of various animal phyla.
- Comprehend the economic importance of non-chordates, their interaction with the environment and role in the ecosystem.

Course Content:

Theory [Credits: 3] 45 hrs/ 100 marks(70 for end exam, 30 for Internal assessment)

Unit 1: Animalia, Non- Chordates : Protista, Porifera 9 hrs/ 14 marks

Characteristics of Animalia and Basis of Classification; Classification & Characters up to Classes for Protista; Life cycle and pathogenicity of *Plasmodium* sp.; Mode of Nutrition, Locomotion and Reproduction in Protista. Introduction to Parazoa/ Porifera; General characteristics and Classification up to Classes; Skeleton & Canal systems in sponges, Economic importance of Sponges

Unit 2: Cnidaria, Ctenophora & Platyhelminthes 9 hrs/ 14 marks

Introduction to Metazoa: General characteristics and Classification up to Classes of Coelenterata; Metagenesis in *Obelia;* Regeneration in *Hydra*; Polymorphism in Coelenterata; Morphology, sense organs, reproductive system & Life Cycle of *Aurelia*; Corals and coral reefs, Structural organization and affinities in Coelenterata. General characteristics and evolutionary significance of Ctenophora;

General characteristics and Classification up to Classes of Platyhelminthes; Morphology, Nervous system, Reproductive system, Life cycle and pathogenicity of *Fasciola hepatica* and *Taenia solium*.

Unit 3: Nemathelminthes, Coelomates & Annelida 9 hrs/ 14 marks

General characteristics and Classification up to Classes of Nemathelminthes; Morphology, Life cycle and pathogenicity of *Ascaris lumbricoides;* Parasitic adaptations in Nemathelminthes; Evolution of coelom and metamerism. General characteristics and Classification up to Classes for Annelida; Coelom, Excretion, Nervous systems and Reproduction in Annelida, Trochophore larva – structure & affinities.

Unit 4: Arthropoda, Onychophora & Mollusca 9 hrs/ 14 marks

Structural organization in different Classes of Arthropods, Mouth parts of Insects, Vision and Respiration in Arthropoda; Metamorphosis in Insects; Social life in bees, Larval forms of Crustacea and Insecta. External morphology, Digestive, Reproductive & respiratory systems of *Palaemon* sp. General characteristics and Evolutionary significance of Onychophora, General characteristics and Classification up to Classes of Mollusca; Structural organization in Pelecypoda, Gastropoda and Cephalopoda, Torsion and detorsion in Gastropoda; Structure and affinities of Neopilina, Pearl formation in bivalves

Unit 5: Echinodermata & Minor Phyla 9 hrs/ 14 marks

General characteristics and Classification up to Classes of Echinodermata; Water-vascular system in Asteroidea; Larval forms in echinoderms. Introduction to minor phyla. Distinguishing characters and examples of Nemertinea, Rotifera, Acanthocephala, Sipunculida, Echiurida, Bryozoa (Ectoprocta), Brachyopoda, Phoronida etc.

Major – I Practical: MJC45ZOO101(P)25

Practical [Credit 1] **30 hrs/50 marks**

1. Study of the whole mounts of *Euglena*, *Amoeba, Paramecium (including* Binary fission and Conjugation), *Obelia, Physalia, Aurelia, Tubipora, Gorgonia, Metridium*/*Adamsia, Pennatula, Fungia, Madrepora, Sycon, Hyalonema, Spongilla, Fasciola hepatica & life cycle stages*, *Taenia solium , Ascaris lumbricoides,* Aphrodite, Nereis, Heteronereis, Serpula, Chaetopterus, Hirudinaria, Limulus, Palamnaeus, Palaemon, Sacculina, Cancer, Eupagurus, Scolopendra, Julus, Apis, Musca, Peripatus, Chiton, Dentalium, Pila, Unio, Pinctada, Sepia, Octopus, Nautilus, Pentaceros/Asterias, Ophiura, Echinus, Cucumaria.
2. Study of T.S. of *Sycon,* L.S. of *Sycon,* T.S. through pharynx, gizzard, and intestine of earthworm
3. Temporary mounts of Ovary of Earthworm; Parapodia of Nereis; Mouth parts of house fly & mosquito; Radula of Pila; whole mounts of *Daphnia*, Cyclops.
4. Dissection of digestive, reproductive and excretory system of Cockroach; Dissection of digestive and nervous system of Pila.

Note: Classification of Animals to be followed from "Barnes, R.D. (2006). *Invertebrate Zoology*, VII Edition, Cengage Learning, India"

Examination evaluation Structure:

1. Museum Specimen: 4 Numbers/ 5 marks each (Identification =1, Classification= 2, Characters = 2) Total = 20 marks
2. Study of Sections (Slides): 1 number/ 2 marks (Identification with reasons = 2)
3. Dissections : 1 number /10 marks (Dissection : 7; Display: 3)
4. Temporary mounts : 1 number/ 3 marks (Slide making : 2 , display : 1)
5. Note Book: 5 marks (Based on the neatness, inclusiveness, overall presentation)
6. Viva-Voce: 10 marks (Testing of Knowledge in the said Course)

Teaching and Learning Process:

Information and concepts about morphology, anatomy and physiology of non-chordates will be imparted through classroom lectures to inculcate a conceptual base among the students about the subject and through observations in nature through real animals/preserved specimens/models. Hands-on exposure would be provided to the students leading to more comprehensive learning. Blended learning using chalk-n-talk method and e-learning using presentations, animations, simple animal model systems, etc. would be used to enhance their conceptual understanding. Inquiry-based collaborative learning environment through presentations, group discussions and round tables on the various aspects of non- chordate biology would be created to ensure effective learning and understanding of the concepts. Field-based project activities have been included to create interest among the students to study and explore the biology and behaviour of non-chordates inculcating research aptitude. In addition, study of animals in their natural habitat will improve the observation skills, data collection skills, critical thinking and analytical skills of students. Furthermore, museology will give them a comprehensive idea of structural features of non- chordates and the basis of classification. Curriculum-related assignments would improve the reading, writing and abstracting skills and enhance the critical thinking of the students. After completion of each unit there should be a doubt clearing session/Class in order to test whether the teaching imparted had been followed by the Students.

Assessment Methods:

Measures to be adopted for assessment are as follows.

- **Class Tests**: Regular class tests will judge the grasp of the topics by the students.
- **Projects and Assignments**: Individual/group projects will inculcate independent thinking as well as the team work skills among the students.
- **Regular Presentations**: Presentations by the students on a particular topic will enhance student's learning and confidence. The presentations will be assessed based on the content, novelty, explanation and response to queries raised by peers.
- ***Viva-voce****: Viva-voce* is another critical component of assessment of the practical component of a course. Inquiry-based learning blended with hands-on learning will develop critical thinking and competencies among students.
- **Semester-end Examination**: Semester-end examination and grading of students based on their performance in the exams is an indicator of student's learning throughout the semester. A comparative assessment of students through final exams, analyses comprehensive knowledge gained by each student.

Recommended Books:

- Barnes, R.D. (2006). Invertebrate Zoology, VII Edition, Cengage Learning, India.
- Pechenik, J. A. (2015). Biology of the Invertebrates. VII Edition, McGraw-Hill Education
- Ruppert, E.E., Fox, R.S., Barnes, R. D. (2003). Invertebrate Zoology: A Functional Evolutionary Approach. VII Edition, Cengage Learning, India
- 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
- Barrington, E.J.W. (2012). Invertebrate Structure and Functions. II Edition, EWP Publishers

Online Tools and Web Resources:

- Animal Diversity (https://swayam.gov.in/courses/5686-animal-diversity), Advances in Animal diversity, Systematics and Evolution (https://swayam.gov.in/courses/5300-zoology) Swayam (MHRD) Portal
- ePG Pathshala (MHRD) Module 10, 18, 19 of the paper P-08 (Biology of Parasitism) https://epgp.inflibnet.ac.in/ahl.php?csrno=35

Minor -I: MNC45**ZOO101(T)25**

(**Fundamentals of Zoology – 1**: Non- Chordates)

Objective:

The course is aimed with the objective of providing knowledge of the diversity of animal life especially among the non Chordates. It shall provide an insight to the learner about the existence of different life forms on the Earth, and appreciate the diversity of animal life. Morphological and anatomical features of diverse animal groups; their significance and their relationships have been incorporated to create interest among the students to explore the animal diversity in nature.

Outcome:

The outcome expected on completion of Course:

- Having knowledge of habitat and structural organization of non- chordates .
- Appreciate the diversity of non-chordates living in diverse habit and habitats.
- Critically think about the organization, complexity and characteristic features of non-chordates.
- Getting familiarized with the morphology and anatomy of representatives of various animal phyla.
- Comprehend the economic importance of non-chordates, their interaction with the environment and role in the ecosystem.

Course Content:

Theory [Credits: 3] 45 hrs/ 100 marks(70 for end exam, 30 for Internal assessment)

Unit 1: Animalia, Protista, Porifera 9 hrs/ 14 marks

Characteristics of Animalia; Characters up to classes for Protozoans; Life cycle and pathogenicity of *Entamoeba histolytica;* Introduction to Parazoa/ Porifera; General characteristics and Classification up to classes of Porifera; Water Canal systems in sponges, Economic importance of Sponges

Unit 2: Cnidaria, Ctenophora & Platyhelminthes 9 hrs/ 14 marks

Introduction to Metazoa: General characteristics and Classification up to classes of Coelenterata; Regeneration in *Hydra*; Life Cycle of *Aurelia*; Corals and coral reefs, Statocyst of a Ctenophora; General characteristics and Classification up to classes of Platyhelminthes; Difference between Trematoda & Cestoda; Morphology, Life cycle and pathogenicity of *Fasciola hepatica* and *Taenia solium*.

Unit 3: Nemathelminthes, Coelomates & Annelida 9 hrs/ 14 marks

General characteristics and Classification up to classes of Nemathelminthes; Morphology, Life cycle and pathogenicity of *Ascaris lumbricoides;* Parasitic adaptation in Nematodes; General characteristics and Classification up to classes for Annelida; Difference of *Neanthes* and *Heteroneris*; Morphology, Digestive system, Circulatory system, Excretory system and Reproductory system of Earthworm.

Unit 4: Arthropoda, Onychophora & Mollusca 9 hrs/ 14 marks

Structural organization in different classes of Arthropods; Types, morphology, life history and economic importance of mosquito; Social life in bees, Economic importance of Insects, Metamorphosis in Insects. General characteristics of Onychophora, General characteristics and Classification up to classes of Mollusca; External features, digestive system, Nervous system in *Pila* sp., Pearl formation in bivalves

Unit 5: Echinodermata & Minor Phyla 9 hrs/ 14 marks

General characteristics and Classification up to classes of Echinodermata; Water-vascular system, Larval forms in echinoderms. Introduction to minor phyla. General characters of Acanthocephala, Echiurida, Bryozoa and Rotifera.

Minor -I Practical: MNC45**ZOO101(P)25**

(**Fundamentals of Zoology – 1**: Non- Chordates)

Practical [Credit 1] **30 hrs/50 marks**

1. Study of the whole mounts of *Amoeba, Obelia, Physalia, Aurelia, Pennatula, Sycon, Hyalonema, Spongilla, Fasciola hepatica & life cycle stages*, *Taenia solium , Ascaris lumbricoides,* Aphrodite, Nereis, Heteronereis, Serpula, Chaetopterus, Hirudinaria, Limulus, Palamnaeus, Palaemon, Sacculina, Julus, Apis, Musca, Peripatus, Chiton, Dentalium, Pila, Unio, Pinctada, Sepia, Octopus, Asterias.
2. Study of T.S. of *Sycon,* T.S. through pharynx, gizzard, and intestine of earthworm
3. Temporary mounts of Obelia colony; Mouth parts of mosquito; whole mounts of Daphnia, Cyclops.
4. A Project on the Study of the Life Cycle of an Insect.

Note: Classification of Animals to be followed from "Barnes, R.D. (2006). *Invertebrate Zoology*, VII Edition, Cengage Learning, India"

Examination evaluation Structure:

1. Museum Specimen: 4 Numbers/ 5 marks each (Identification =1, Classification= 2, Characters = 2) Total = 20 marks
2. Study of Sections (Slides): 1 number/ 2 marks (Identification with reasons = 2) Total = 2
3. Temporary mounts : 2 numbesr/ 3 marks (Slide making : 2 , display : 1) Total=6
4. Project report submission : 7 marks
5. Note Book: 5 marks (Based on the neatness, inclusiveness, overall presentation)
6. Viva-Voce: 10 marks (Testing of Knowledge in the said Course)

Teaching and Learning Process:

Information and concepts about morphology, anatomy and physiology of non-chordates will be imparted through classroom lectures to inculcate a conceptual base among the students about the subject and through observations in nature through real animals/preserved specimens/models. Hands-on exposure would be provided to the students leading to more comprehensive learning. Blended learning using chalk-n-talk method and e-learning using presentations, animations, simple animal model systems, etc. would be used to enhance their conceptual understanding. Inquiry-based collaborative learning environment through presentations, group discussions and round tables on the various aspects of non- chordate biology would be created to ensure effective learning and understanding of the concepts. Field-based project activities have been included to create interest among the students to study and explore the biology and behaviour of non-chordates inculcating research aptitude. In addition, study of animals in their natural habitat will improve the observation skills, data collection skills, critical thinking and analytical skills of students. Furthermore, museology will give them a comprehensive idea of structural features of non- chordates and the basis of classification. Curriculum-related assignments would improve the reading, writing and abstracting skills and enhance the critical thinking of the students. After completion of each unit there should be a doubt clearing session/Class in order to test whether the teaching imparted had been followed by the Students.

Assessment Methods:

Measures to be adopted for assessment are as follows.

1. **Class Tests**: Regular class tests will judge the grasp of the topics by the students.
2. **Projects and Assignments**: Individual/group projects will inculcate independent thinking as well as the team work skills among the students.
3. **Regular Presentations**: Presentations by the students on a particular topic will enhance student's learning and confidence. The presentations will be assessed based on the content, novelty, explanation and response to queries raised by peers.
4. ***Viva-voce****: Viva-voce* is another critical component of assessment of the practical component of a course. Inquiry-based learning blended with hands-on learning will develop critical thinking and competencies among students.
5. **Semester-end Examination**: Semester-end examination and grading of students based on their performance in the exams is an indicator of student's learning throughout the semester. A comparative assessment of students through final exams, analyses comprehensive knowledge gained by each student.

Recommended Books:

1. Barnes, R.D. (2006). Invertebrate Zoology, VII Edition, Cengage Learning, India.
2. Pechenik, J. A. (2015). Biology of the Invertebrates. VII Edition, McGraw-Hill Education
3. Ruppert, E.E., Fox, R.S., Barnes, R. D. (2003). Invertebrate Zoology: A Functional Evolutionary Approach. VII Edition, Cengage Learning, India
4. 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
5. Barrington, E.J.W. (2012). Invertebrate Structure and Functions. II Edition, EWP Publishers

Online Tools and Web Resources:

1. Animal Diversity (https://swayam.gov.in/courses/5686-animal-diversity), Advances in Animal diversity, Systematics and Evolution (https://swayam.gov.in/courses/5300-zoology) Swayam (MHRD) Portal
2. ePG Pathshala (MHRD) Module 10, 18, 19 of the paper P-08 (Biology of Parasitism) https://epgp.inflibnet.ac.in/ahl.php?csrno=35

MULTI-DISCIPLINARY COURSE – 1 : MDC45ZOO101(T)25

(Introduction to Animal Diversity – 1 : non-Chordates)

Objective:

The course is aimed with the objective of providing introductory ideas of the diversity of animal life among the non-Zoology Students offering this MDC. It shall provide an insight to the learner about the existence of different life forms on the Earth, and appreciate the diversity of animal life.

Outcome:

The outcome expected on completion of Course:

- Having knowledge of habitat and structural organization of animals .
- Appreciate the diversity of non-chordates living in diverse habit and habitats.
- Critically think about the organization, complexity and characteristic features of non-chordates.
- Getting familiarized with the morphology and anatomy of representatives of various animal phyla.
- Comprehend the economic importance of non-chordates, their interaction with the environment and role in the ecosystem.

Course Content:

Theory [Credits: 3] 45 hrs/ 100 marks(70 for end exam, 30 for Internal assessment)

Unit 1: Origin of Life; Introduction to Animals 9 hrs/ 14 marks

Origin of life on Earth: Arrival of simple form from primordial chemicals Complexity of Life: Origin of metazoans; Concept of Cellularity, Body symmetry, Germ layers & Body cavities Sequence & strategies of life cycle: Concept of classification of life cycles, adaptations & relationship between ontogeny & phylogeny. Characteristics of Animalia; Difference of living animals & non-living things; Animals in Mythology and Indian knowledge systems.

Unit 2: Single Cell organisms to Platyhelminthes 9 hrs/ 14 marks

Physical characteristics, and medical importance of Protozoans; General characteristics and Economic importance of Sponges; Introductory ideas of the Water Canal systems in sponges. Introduction to Metazoa: General characteristics of Coelenterata; Regeneration in *Hydra*; Characters & importance of Jelly fishes; Corals and coral reefs; General characteristics of Platyhelminthes; Difference between Trematoda & Cestoda; Life cycle & medical importance of Liver fluke and common Tape worm.

Unit 3: Nemathelminthes to Annelida 9 hrs/ 14 marks

General characteristics of a Nematode; Life cycle and importance of roundworm; Medical importance of Nematodes specially in relation to immunocompromised Persons; General characteristics of Annelida; Life cycle of Earthworm and Leech. Earthworm as a friend of the Farmers & their rearing for sustainable use; Identification using diagrammatic sketches or Photographs with characters & Medicinal uses of Leeches.

Unit 4: Arthropoda to Onychophora 9 hrs/ 14 marks

Structural organization in different classes of Arthropods; Types, morphology, life history and economic importance of mosquito; characters & life history of Spiders, characters of Centipedes & millipedes; Social life in bees, Economic importance of Insects, Metamorphosis in Insects.

Harmful effects of Barnacles in water; General characteristics of Onychophora.

Unit 5: Mollusca to Minor Phyla 9 hrs/ 14 marks

General characteristics of Mollusca; External features & introductory ideas on the digestive system & Nervous system in *Pila* sp., Pearl formation in bivalve. General characteristics of Echinodermata; Water-vascular system, Larval forms in echinoderms. Introduction to minor phyla. General characters of some important groups of minor phyla.

Teaching and Learning Process:

Information and concepts about morphology, anatomy and physiology of non-chordates will be imparted through classroom lectures to inculcate a conceptual base among the students about the subject and through observations in nature through real animals/preserved specimens/models. Hands-on exposure would be provided to the students leading to more comprehensive learning. Blended learning using chalk-n-talk method and e-learning using presentations, animations, simple animal model systems, etc. would be used to enhance their conceptual understanding. Inquiry-based collaborative learning environment through presentations, group discussions and round tables on the various aspects of non- chordate biology would be created to ensure effective learning and understanding of the concepts. Field-based project activities have been included to create interest among the students to study and explore the biology and behavior of non-chordates inculcating research aptitude. In addition, study of animals in their natural habitat will improve the observation skills, data collection skills, critical thinking and analytical skills of students. Furthermore, museology will give them a comprehensive idea of structural features of non- chordates and the basis of classification. Curriculum-related assignments would improve the reading, writing and abstracting skills and enhance the critical thinking of the students. After completion of each unit there should be a doubt clearing session/Class in order to test whether the teaching imparted had been followed by the Students.

Assessment Methods:

Measures to be adopted for assessment are as follows.

Class Tests: Regular class tests will judge the grasp of the topics by the students.

Projects and Assignments: Individual/group projects will inculcate independent thinking as well as the team work skills among the students.

Regular Presentations: Presentations by the students on a particular topic will enhance student's learning and confidence. The presentations will be assessed based on the content, novelty, explanation and response to queries raised by peers.

Viva-voce*: Viva-voce* is another critical component of assessment of the practical component of a course. Inquiry-based learning blended with hands-on learning will develop critical thinking and competencies among students.

Semester-end Examination: Semester-end examination and grading of students based on their performance in the exams is an indicator of student's learning throughout the semester. A comparative assessment of students through final exams, analyses comprehensive knowledge gained by each student.

Recommended Books:

Barnes, R.D. (2006). Invertebrate Zoology, VII Edition, Cengage Learning, India.

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

Barrington, E.J.W. (2012). Invertebrate Structure and Functions. II Edition, EWP PublishersPechenik, J. A. (2015). Biology of the Invertebrates. VII Edition, McGraw-Hill Education

Ruppert, E.E., Fox, R.S., Barnes, R. D. (2003). Invertebrate Zoology: A Functional Evolutionary Approach. VII Edition, Cengage Learning, India

Online Tools and Web Resources:

Animal Diversity (https://swayam.gov.in/courses/5686-animal-diversity), Advances in Animal diversity, Systematics and Evolution (https://swayam.gov.in/courses/5300-zoology) Swayam (MHRD) Portal

ePG Pathshala (MHRD) Module 10, 18, 19 of the paper P-08 (Biology of Parasitism) https://epgp.inflibnet.ac.in/ahl.php?csrno=35

Skill Enhancement Course (SEC) -I: SEC45ZOO101(T)25a

(Aquarium Fish Keeping)

Objective:

The course will impart basic knowledge of ornamental fish Industry and inculcate its scope as an avenue for career development as an entrepreneur or as an aquari-culturist. It will provide a clear understanding of the basics of biology and habits of aquarium fish, so as to facilitate taking up ornamental fish keeping as an enterprise, even at the household level. The skill capacity building of students will be promoted by teaching the techniques of aquarium constructions, feed formulation and preparation, transportation, maintenance and management of the system. Students will have 'hands-on' experience by exposure to technology, production, functioning or operation of an aquarium in the ornamental fish farms, hatcheries, and fish feed production plant as study tours or field visits.

Course Learning Outcome:

Upon completion of the course, students should be able to:

- Acquire knowledge aboutdifferent kinds of fish , their compatibility in aquarium.
- Become aware of Aquarium as commercial, decorative items and of scientific values.
- Develop personal skills on maintenance of aquarium.
- Know about the basic needs to set up an aquarium, i.e., dechlorinated water, reflector, filters,scavenger, aquatic plants etc. and the ways to make it cost-effective.

Course Content:

Theory [Credits: 2] 30 hrs/ 50 marks

Unit 1: Introduction, Biology of Aquarium Fish 12 hrs/20 marks

Aquarium Fish Industry as a Cottage Industry; Exotic and Endemic species of Aquarium Fish , biology (Breeding, Feeding economic importance etc.) , sexual dimorphism of Fresh water and marine aquarium fish such as Guppy, Molly, Sword tail, Gold fish, Angel fish, Blue morph, Anemone fish and Butterfly fish

Unit 2: Food and Feeding of Aquarium Fish 6 hrs/10 marks

Use of live fish feed organisms (Advantages and disadvantages of live food), Use of formulated feeds, Types of formulated feed, Formulation and preparation of feed, Advantages and disadvantages of formulated feed

Unit 3: Fish Transportation and Maintenance of Aquarium 12 hrs/20 marks

Live fish transport (Capture and Pre-transport maintenance, capture and handling techniques); Fish packing and transport (Closed and open transport system, Preparation for packaging, Procedure for packaging, Precautions, Post transport maintenance) General handling techniques. General aquarium maintenance - budget for setting up an Aquarium Fish Farm as a cottage industry.

Skill Enhancement Course (SEC) -I Practical : SEC45ZOO101(P)25a

(Aquarium Fish Keeping)

Practical [Credit: 2] 30 hrs/ 50 marks

1. Study of different species of Aquarium fish and biology (Breeding, Feeding economic importance etc.) of exotic and endemic fish.
2. Study of sexual dimorphism of fresh water and marine aquarium fish (Guppy, Molly, Sword tail, Gold fish, Angel fish, Blue morph, Anemone fish, Butterfly fish)
3. Type, composition and formulation of fish feed (using Pearson Square Methods)
4. Construction and maintenance of Glass Aquarium and Filter System using indigenous Locally available materials.
5. Monitoring of aquarium water quality (temperature, pH, dissolved oxygen, carbon dioxide, ammoniacal N-load) through titrimetric methods.
6. To write a project proposal for setting up a small aquarium fish keeping as a cottage industry to a funding agency for self-employment of youths or for helping poor farmers; after visiting any farm/enterprise.

Examination evaluation Structure:

1. Identification & Character of Specimen: 3 numbers/ 3 marks (Identification with reasons = 1 + 2 = 3 each). Total = 9 marks
2. Monitoring of Water quality : procedure & result – 10 marks
3. Project proposal: 15 marks (Subject content, Presentation, Diagrams/Photos)
4. Note Book: 6 marks (Based on the neatness, inclusiveness, overall presentation)
5. Viva-Voce: 10 marks (Testing of Knowledge in the said Course)

Teaching and Learning Process:

Teaching Learning must include the videos, surveys, presentation to show the significance of the course- its commercial, scientific and aesthetic prospects. Learning must include a visit toany farm or lab by students. Practical exercise with the setup of an aquarium and its maintenance; hands-on training for the formation of feeds will develop skill among students.

Assessment Methods:

Measures to be adopted for assessment are as follows-

- **Class Tests**: Regular class tests will judge the grasp of the topics by the students.
- **Projects and Assignments**: Individual/group projects will inculcate independent thinking as well as the team work skills among the students.
- **Regular Presentations**: Presentations by the students on a particular topic will enhance student's learning and confidence. The presentations will be assessed based on the content, novelty, explanation and response to queries raised by peers.
- ***Viva-voce****: Viva-voce* is another critical component of assessment of the practical component of a course. Inquiry-based learning blended with hands-on learning will develop critical thinking and competencies among students.
- **Semester-end Examination**: Semester-end examination and grading of students based on their performance in the exams is an indicator of student's learning throughout the semester. A comparative assessment of students through final exams, analyses comprehensive knowledge gained by each student.

Recommended Books:

- Dawes, J. A. (1984) The Freshwater Aquarium, Roberts Royee Ltd. London.
- Gunther, A. (1980) An Introduction to the Study of Fishes. A and C. Black Edinburgh.
- Jhingran, V.G. (1982) Fish and Fisheries in India. Hindustan publication Corp, India.
- Pandey, K and J.P. Shukla (2013) Fish and Fisheries. Rastogi publication

Skill Enhancement Course (SEC) -I: SEC45ZOO101(T)25b

(Apiculture)

Objective:

The course will make the student aware about the significance of beekeeping as an economically viable industry. It will help the students to understand the biology and behaviour of bees. It will also help the students to develop entrepreneurial skills required for self-employment in beekeeping sector specially on the techniques of honey bee rearing, optimization of techniques based on climate and the geographical regions, and various measures to be taken to maximize the benefits.

Outcome:

Upon completion of the course, students shall be able to:

- Learn about the various species of honey bees, their social organization and importance.
- Share knowledge about the opportunities and employment in apiculture- in public, private and government sector.
- Gain thorough knowledge about the techniques involved in bee keeping and honey production.
- Know about various products obtained from beekeeping sector and their importance.
- Develop entrepreneurial skills necessary for self-employment in beekeeping sector.

Course Content:

Theory [Credits: 2] 30 hrs/ 50 marks

Unit1: Biology of Bees 10 hrs/ 15 marks

History, Systematics and biology of Honey Bees, different species of honey, distribution & occurrence of Honey bees in North East India, Polymorphism, Social Organization of bee colony, behavioral patterns (Bee dance, swarming), Dispersal and foraging methods for Pollen and Nectar collection.

Unit 2: Rearing of Bees 10 hrs/ 15 marks

Apiculture practices, rearing methods, 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) and processing; Apiary management- Honey flow period and Lean period

Unit 3: Bee Economy, Diseases and Enemies 3 hrs/ 20 marks

Bee Products (Honey, Bees Wax, Propolis, Royal jelly, Pollen etc.) and their uses; Properties of Honey and economic values, Modern methods in employing artificial beehives for cross pollination in horticultural gardens. Bee diseases, control and preventive measures, Enemies of bees.

Skill Enhancement Course (SEC) -I Practical : SEC45ZOO101(P)25b

(Apiculture)

Practical [Credit: 2] 30 hrs/ 50 marks

1. Study of the life history of a common honey bee - Egg, larva, pupa, adult (queen, drone, worker) from Photograph or preserved specimen.
2. Study of natural bee hive and identification of queen cells, drone cells and brood
3. Study of morphological structures of honey bee through permanent slides/photographs- mouth parts, antenna, wings, legs (antenna cleaner, mid leg, pollen basket), sting apparatus.
4. Permanent/temporary mount of antenna cleaner, mid leg and pollen basket.
5. Study of artificial hive (Langstroth/Newton), its various parts and beekeeping equipment.
6. Visit to an apiary/honey processing unit/Institute and submission of a report.

Examination evaluation Structure:

1. Identification & Character of Slides/ Specimen: 6 numbers/ 3 marks (Identification with reasons = 1 + 2 = 3)
2. Project report: 15 marks (Subject content, Presentation, Diagrams/Photos)
3. Note Book: 7 marks (Based on the neatness, inclusiveness, overall presentation)
4. Viva-Voce: 10 marks (Testing of Knowledge in the said Course)

Teaching and Learning Process:

Information and concepts about benefits of honey bees in human life and how these benefits can be reaped will be imparted through classroom lectures to inculcate a conceptual base among the students about the subject. Learning through observations of bees in nature and study of rearing technology will be assisted through visits to various apiculture institutes which will create interest, enhance their understanding and inculcate entrepreneurial skills among students to set up SMEs. Blended learning including chalk-n-talk method and e-learning will be encouraged to make learning by students more dynamic. Inquiry-based collaborative learning environment through presentations, debates, group discussions, and roundtables on the various aspects of bee biology will be promoted to not only ensure effective learning and understanding of the concepts, but also to inculcate confidence in the students. Field-based project activities and hands-on exposure have been added to make students aware about handling of bees andtheir rearing methods. Collection of plants and bee products will also help students to know the benefits of apiculture. Visit to various apiculture institutes will clarify their concepts about the bees and their rearing technology.

Assessment Methods:

Measures to be adopted for assessment are as follows-

- **Class Tests**: Regular class tests will judge the grasp of the topics by the students.
- **Projects and Assignments**: Individual/group projects will inculcate independent thinking as well as the team work skills among the students.
- **Regular Presentations**: Presentations by the students on a particular topic will enhance student's learning and confidence. The presentations will be assessed based on the content, novelty, explanation and response to queries raised by peers.
- ***Viva-voce****: Viva-voce* is another critical component of assessment of the practical component of a course. Inquiry-based learning blended with hands-on learning will develop critical thinking and competencies among students.

- **Semester-end Examination**: Semester-end examination and grading of students based on their performance in the exams is an indicator of student's learning throughout the semester. A comparative assessment of students through final exams, analyses comprehensive knowledge gained by each student.

Recommended Books:

- Singh S. (1962): Beekeeping in India, Indian Council of Agricultural Research, New Delhi.
- Mishra, R. C. (1995): Honeybees and their Management in India. Indian Council of Agricultural Research, New Delhi.
- David, B.V. and Anathakrishnan, T.N. (2004): General and applied entomology. Mc Graw Hill education (India) Pvt Ltd., New Delhi
- Davis, B.V. and Ramamurthy, V.V. (2013): Elements of Economic Entomology. Namrutha Publication, Chennai
- Gupta, J. K. (2016): Apiculture, Indian Council of Agricultural Research, New Delhi
- Prost, P. J. (1962): Apiculture. Oxford and IBH, New Delhi.
- Rahman, A. (2017): Beekeeping in India. Indian Council of Agricultural Research, New Delhi

Online Tools and Web Resources:

- (https://www.ecornell.com/certificates/beekeeping/master-beekeeping/)
- Beekeeping (https://nios.ac.in/media/documents/nsqf/beekeeping%20theory.pdf)
- Swayam (MHRD) Portal Vocational Beekeeping (https://swayam.gov.in/courses/5844-vocational-beekeeping
- Apiculture - an overview/ Science Direct Topics. https://www.Sciencedirect.com

Skill Enhancement Course (SEC) -I: SEC45ZOO101(T)25c
(Poultry Farming)

Objective:

The course is aimed with the objective of providing knowledge of the Poultry farming; their significance, types & breeds. Modern system of rearing and breeding of Broilers have been incorporated in order to create interest among the Students to explore this system of practice.

Outcome:

The outcome expected on completion of Course:

- Having knowledge of different Poultry birds & rearing practices.
- Understand the economic importance of these birds, Feed preparation, Scientific rearing practices and control of diseases.

Course Content:

Theory [Credits: 2] 30 hrs/ 50 marks

Unit 1: Introduction to Poultry Industry and Diversified Poultry 12 hrs/20 marks

Importance; present status and future prospects of poultry industry; classification of chicken; introduction to ducks, geese, quails, guinea fowls and turkey; improved varieties of chicken; economic aspects of ratites, emu and ostrich

Unit 2: Feeds additives and formulation 6 hrs/10 marks

Feeds: definition; antibiotics; anti-oxidants-their roles in nutrition; supplements used; good quality feed ingredients, cost, availability, storage, etc.; mixing of feeds, different mills used (Hammer, mixture, pellet); premix preparation, raw materials, feed mill operation.

Unit 3: Scientific Poultry Keeping, Diseases 12 hrs/20 marks

Modern breeding; egg and meat production; hatchery managements; farm equipment for broilers rearing; brooding system; multiple batch system; water and feed management; sanitation litter management; performance indices and records. Diseases – types, symptoms, prevention and control. Vaccination program.

Skill Enhancement Course (SEC) -I Practical : SEC45ZOO101(P)25c

(Poultry Farming)

Practical [Credit: 2] 30 hrs/ 50 marks

1. Demonstration of breeds of chicken, Ducks, Geese, Turkeys, Quails, Guinea Fowls, Ratite etc.
2. Nutrient required in poultry name of feed ingredient, nutritive value in term of C.P% and M.E in k.cal/kg of feeds like animal source, plant source synthetic source
3. Estimation of protein in a given sample by Kjeldal flask method.
4. Preparation of feed (Selection of ingredient, feed formulation, grinding, mixing).
5. Faecal sample examination and identification of parasites, isolation of disease causing organism.
6. Project work on Broiler management and report submission.

Examination evaluation Structure:

1. Identification & Characters of different breeds of Poultry birds (live/Photo) : 3 numbers/ 3 marks (Identification with reasons = 1 + 2 = 3 each). Total = 9 marks

2. Monitoring of Nutritive value, Protein content: procedure & result – 5 marks

3. Faecal sample examination: Identification of Parasites with reasons & drawing of diagram (1 + 2 + 3 = 6)

2. Project Report: 15 marks (Subject content, Presentation, Diagrams/Photos)

3. Note Book: 5 marks (Based on the neatness, inclusiveness, overall presentation)

4. Viva-Voce: 10 marks (Testing of Knowledge in the said Course)

Teaching and Learning Process:

Teaching Learning must include the videos, surveys, presentation to show the significance of the course- its commercial, scientific and aesthetic prospects. Learning must include a visit toany farm or lab by students. Practical exercise and hands on experience at a farm will develop skill among students.

Assessment Methods: Measures to be adopted for assessment are as follows -

- **Class Tests**: Regular class tests will judge the grasp of the topics by the students.
- **Projects and Assignments**: Individual/group projects will inculcate independent thinking as well as the team work skills among the students.
- **Regular Presentations**: Presentations by the students on a particular topic will enhance student's learning and confidence. The presentations will be assessed based on the content, novelty, explanation and response to queries raised by peers.
- ***Viva-voce****: Viva-voce* is another critical component of assessment of the practical component of a course. Inquiry-based learning blended with hands-on learning will develop critical thinking and competencies among students.
- **Semester-end Examination**: Semester-end examination and grading of students based on their performance in the exams is an indicator of student's learning throughout the semester.A comparative assessment of students through final exams, analyses comprehensive knowledge gained by each student.

Reference Books:

- Nadam, R. (2015): Handbook of Poultry farming and feed formulations. Anmol publications Pvt Ltd.
- Das *et al.* (2021); Text book on Poultry management. Narendra Publishing house

Online Tools and Web Resources:

https://www.growelagrovet.com

http: //www.asci-india.com

https://dahd.nic.in