

Fish and Fisheries

Course title: Fish and Fisheries

Full Marks: 100

Course No. Zool. 631

Pass Marks: 40

Nature of the course: Theory

Year: II

Course description: Taxonomy, Anatomy, Physiology and Behaviour

Course objectives:

Course Contents:

Fishery Systematics and Evolution:

18 hrs

Principles of Zoological Classification of fishes: Taxonomic collections and the process of identification taxonomic characters of fishes; taxonomic revisions on the species level and the procedure of classifying. The rules of zoological nomenclatures, international code of zoological nomenclature; interpretation of the rules of zoological nomenclature. **Evolution:** Theories of organic evolution; the process and patterns of evolution in fishes; evolution at the molecular level. Nature, modes and types of speciation. **Strategies of taxonomic research:** Introduction of biochemical techniques such as protein and DNA analysis (DNA fingerprinting) for identification of species. Taxonomic publications. **Classification and distribution:** Classification and distribution of fresh water fishes of Nepal.

Anatomy and Physiology: Digestive system:

40 credit

Food and feeding habit, digestive organs, morphology, histology and physiology of digestion. Metabolism, metabolic rate and energy metabolism. **Respiratory system:** Respiratory organs, structure of gills in typical fresh water fishes, counter current mechanism, gas exchange, blood as a gas carrying substance, accessory respiratory organs, origin and significance of air breathing organs. **Blood vascular system:** Structure

of hearts in typical fresh water fishes and different groups of fishes, arterial and venous system including afferent and efferent blood vessels in different groups of fishes, physiology of blood circulation. **Excretory system:** Structure of kidney and their ducts in typical fresh water fishes and different groups of fishes, pattern of nitrogenous waste excretion and osmo-regulation. **Air bladder and weberian ossicles:** Structure, function and modification of air bladder and weberian ossicle in different groups of fishes. **Nervous system:** Central, peripheral and autonomic nervous system and their modification in different groups of fishes. Structure and function of olfactory organs, taste buds, touch receptors, photoreceptors and lateral line system. **Reproduction:** Structure of reproductive organs in typical fresh water fishes and different groups of fishes. **Embryonic development:** Gametogenesis, fertilization in fishes, mechanism of sperm-egg interactions; hypotheses of egg activation; interaction and fusion of gametes; prevention of polyspermy; formation, hardening and break down of egg envelope. Cleavage, blastulation, gastrulation, fate of cells, organogenesis, hatching, yolk sac absorption mechanisms, post larval development. **Endocrine glands:** General concept of endocrinology, organization of the endocrine system, hormone synthesis, release and transport; receptor mechanisms; hormone action mechanisms; hormonal interrelations. Neuroendocrinology: Concept of neurosecretion; control of endocrine system; hormonal actions on the brain. Anatomy and histophysiology; secretions, functions and mechanisms of pituitary gland, thyroid gland, pancreas, testes and ovary. Roles of the hormones on the life processes and breeding processes of fish and its impact on aquaculture.

Fish Behaviour:

7 credit

Introduction: Factors responsible for fish behaviour. Feeding behaviour and cannibalism in fishes. Reproductive behaviour. Response of fishes to gonadal changes and maturation. Breeding behaviour: Courtship, pairing and parental care. Behaviour of diseased fish. Factors causing abnormal behaviour. Behaviour as a tool of fish catching.

Introduction: Genetic constitution of a population and genetic variations. Genetic drift and its effect on population, size, sexes. Genetic aspects of endangered populations, genetical conservation of exploited. Fishes (gene banking). Application of genetics in taxonomy. **Application of genetics in Aquaculture:** Artificial breeding of commercially important fishes in hatcheries. Genetic management of brood stocks, problems identified with existing fish stocks and hatchery operations. Short and long term plans for brood stock development in hatcheries. Inbreeding: Inbreeding and population size and breeding plans to avoid inbreeding depression. Selective breeding: Selective breeding for qualitative traits, quantitative traits. Hybridization: Planning cross-breeding programs, heterosis and hybrid vigor, effects of unplanned hybridization. **Fish Genetic Engineering and Biotechnology:** Introduction: Prospects for genetic engineering in fishes. Application: Growth enhancement, cold and disease resistance; transgenic fishes. Chromosome manipulation techniques: Polyploidy gynogenesis, androgenesis, production of monosex, sex reversal and sterile fish population. **Molecular Genetics:** The genetic material: physical and chemical structure of DNA. DNA replication, repair and recombination mechanism. Gene cloning: Constructing and isolation of a particular gene/cDNA. Cloning vectors; Plasmids: isolation, general properties and types. Polymerase chain reaction: Theory, techniques and applications. General principles and applications. Molecular Markers: Restriction fragment length polymorphism (RFLP). Amplified fragment length polymorphism (AFLP). Random amplified polymorphic DNA (RAPD). Mini and microsatellite VNTRs. Roles of molecular markers in fisheries and aquaculture. Gene mapping in fish: Status, gene mapping techniques. Molecular biology of fish immune system.

Adaptation:**7 hrs**

Introduction: Effects of environmental factors on the biology of fishes. Adaptation of fishes to salinity and to estuarine conditions, drought conditions and various depth. Fish migration: Types of migration, preconditions for migration, migration of anadromous and catadromous fishes. Scales, spines and poison glands for protection. Electric organs, luminous organ, colour of fishes, buoyancy.

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Pass Marks: 40

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Year: II

Course description: Applied Fisheries Management

Introduction:

3 hrs

Present status of water resources. Development of Fisheries, future trends and aquaculture potentialities of Nepal. **Fishery resources of Nepal:** Indigenous fishery resources. Exotic fish species introduced and their potentialities in aquaculture development. **Fishery Development:** Warm water fishery development in lowland areas of Nepal. Cold water fishery development in highland ponds, raceways, lakes and reservoirs. Status and scope of warm water and cold water fisheries in wetlands of Nepal. Fishery development in swamps and ghols, ditches etc.

Captive Fisheries

7 hrs

Introduction: Traditional fish catching gears, methods used and modern mechanized fishing gears and methods used in Nepal. **Riverine Fisheries:** River ecology and ecosystem of Nepal. Riverine fisheries of Koshi, Gandaki, Karnali and Mahakali River Systems. **Migratory fishes of Nepal:** Long and short distant migrants, dams and their impact on fish Migration. Fish ladder and their utility in fish migration and conservation. **Reservoir fisheries:** Development of Reservoir fisheries in Nepal. Present Level of fishery potential of man made lake and reservoirs (Kulekhani and Kaligandaki). Present level of exploitation and management of reservoirs. **Fishermen Community** - Rituals community and gender based fishery and their status of organization. Role of fisherwomen in aquaculture. Community fishery management, sustainable exploitation through participatory approach. Existing laws and legislation. concerning fish and aquatic

life, Aquatic Animal Protection Act (AAPA), 2017(1961). Revised version of AAPA (1999 AD) etc. Fishery versus Agriculture in Nepal.

Aquaculture:

50 hrs

Principles and concept of aquaculture: Role of aquaculture for poverty reduction. Economics of different kind of aquaculture and bio-productivity of Ponds. Monoculture and polycultural practices. Classification of aquaculture systems based on economic and commercial consideration. (extensive, semi-intensive and intensive), based on operational techniques (cage, pen, raceways culture), based on climatic factors (warm and coldwater aquaculture). **Existing Aquaculture systems:** Culture of some important indigenous species, culture of exotic carps, race-ways trout culture, cage and pen culture, paddy cum fish culture, culture of air-breathing fishes or live fish culture. **Fishery extension:** Extension services training and research activities. National policy and legislation of fish farming and constraints for the development of aquaculture. **Culture of Some Important Cultivable Fishes:** Culture of Indian Major Carps. Systematic position, distinctive feature, life cycle, stocking, feeding of catla (*Catla catla*), rohu (*Labeo rohita* including *Labeo dero*, *Labeo angra*, *Labeo pangasius*, *Labeo calbasu* etc), mrigal (*Cirrhinus mrigala*), mahseer (*T. putitora* and *Tor tor*), katle (*Neolissocheilus hexagonolepis*), snow trout (*Schizothorax* and *Schizothoraichthys* spp.), catfishes (*Clarias batrachus*, *C. gariepinus* and *Pangasius pangasius*), perches (*Anabas testudinus*), *Channa marulius*, tilapia (*Sarotherodon mossambica* and *S. nilotica*), Trout (*Oncorhynchus mykiss*), minnow (*Barilius bola*). **Shrimp culture** (*Macrobrachium rosenbergi*). **Frog culture.** Culture of ornamental fishes and mollusc. **Integrated Fish Farming Technology:** Integrated fish farming and its relevance in the context of Nepal for production of fishes from varied kinds of aquaculture especially monoculture and polyculture. **Different types of integrated fish farming systems:** Fish cum duck culture, fish cum pig culture, fish cum horticulture, fish culture in sewage water, fish culture in Kitchen ponds (homestead ponds). **Culture of Live Fish Food Organisms:** Culture of phytoplankton, culture of zooplanktons (*Moina*, *Daphnia*, *Brachionus*, *Artemia* etc.).

Fishery Management:**12 hrs**

Pond construction: Survey of pond-site, fish pond engineering/designing, construction and layout of ponds. Study of basic features of pond construction (soil, water quality, water quantity and topographical features). Repair and maintenance of ponds. **Types of ponds:** Nursery pond, rearing ponds, brood-stock pond, production pond, raceways etc. **Management of Fish Pond:** Fish Culture operation, water quality improvement, weed control, pond fertilization and manuring, feeding of cultivated fishes, fish harvesting etc. **Fish Transport:** Distribution of fish by transporting fishes cultured in natural waters and imported fishes. Transport of fish seed and marketable fishes. Fish sizes for transport, cause of mortality, physical injury and predation during transport, use of anesthetics in transportation and methods of packing in transportation.

Fish breeding, stock enhancement and improvement :**48 hrs**

Fish Breeding: Natural breeding of fishes. Artificial breeding of commercially important indigenous and exotic fish species. Fish breeding by hypophysation, incubation and hatching, larval rearing and nursery management. **Brood Stock Improvements:** Genetic Management of brood stock for hatchery, problem concerned with fish brood stocks and hatchery operations, long term and short term plans for brood stock development. **Inbreeding:** Fish identify by descent, inbreeding from pedigrees, inbreeding and its effect upon population and size. **Selective breeding:** Selection index theory, suitable model for selective breeding of carps. **Hybridization:** hybrid vigour, growth, quality of flesh traits, survivability and food conversion ratio. **Hatchery Management:** Concept of fish hatchery, hatchery design, incubation, hatching and larval rearing in hatchery. **Fish Farm Management:** Development of Fish Farms in different regions of Nepal. Technical responsibility of Fish Farm Manager. **Fish Nutrition:** Nutritional requirement of a fish, supplementary feeding, different kinds of processed feeds, feeds ingredients and feed formulation, micro-encapsulated diet, FCR (Feed Conversion Ratio) and FCE (Feed Conversion Efficiency). Production of extrusive

pellets for intensive fish farming. Nutrition deficiency and symptoms in fishes and their implication on fish health. **Fish Diseases:** Concept of health and diseases in fish, common fish diseases and parasites, detailed classification of fish diseases. Fish disease investigation, sign and symptoms of fish disease and pathological process for diagnosis. Prevention and control of bacterial, fungal and viral diseases in fishes. Treatment and control of fish leech infection, trematode disease and pancreatic necrosis etc. **Fish Preservation and Processing:** Fish as basic food commodity. Biochemical composition of raw fish, factors affecting biochemical composition and nutritive value of raw and preserved fishes. Fish food poisoning and toxicity. Quality control of fish products in national and international markets. Rational utilization of Fish, fish products and by products. **Different processes of fish preservation:** Salting, pickling, smoking, drying, icing, freeze drying, quick freezing of fishes, refrigerated sea-water (RSW), canning and use of chemical and antibiotics and irradiation etc. Method of transport and preservation of fish during transport. Fishery policy and fishery co-operative, society etc in transport, preservation of fish and marketing. Roles and problems in fisherman co-operatives and society. **Fish Marketing:** Present status of fish marketing in Nepal, consumption level, fish market channel - level and trend. Marketing infrastructure – problems, prospects and potentiality of fish marketing.

Fish and Fisheries

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Full Marks: 100

Course No. Zool. 633

Pass Marks: 40

Nature of the course: Theory

Year: II

Course description: Freshwater Ecology and Research Methodology

Freshwater Ecology:

58 hrs

Freshwater Resources: River systems and their zonation (Carpenter, Huet and Universal Systems), General applicability of the fish zonation concept in Nepal, ecological validity of river zonation, influence of man in zonation. **Lakes and their types:** Origin of lakes, distribution and classification, ecology and application. **Ponds and reservoirs:** Origin, distribution and classification, ecology and application. **Swamps and marshes:** Origin, distribution and classification, ecology and application. Wetland Ecosystem Complex -Swamps, marshes, etc. **Irrigated paddy field:** Introduction, role of irrigated paddy fields in fisheries. **Limnology:** pH., hardness, dissolved oxygen, free carbon dioxide BOD, COD, alkalinity, acidity, chloride, ammonia, orthophosphate, total phosphate, nitrite, total Nitrogen, Silicates etc. Physiography of fresh waters, thermal stratification, buoyancy, temperature, turbidity, depth, colour, current velocity, conductivity etc. Role and importance of water quality in fisheries. Aquatic pollution, bio-indicator of pollution and eutrophication. **Biological Productivity:** Primary and secondary productivity, chlorophyll, plankton, periphyton, benthos and their implication on fisheries. **Carrying Capacity and Implication by Environment:** Inter-relationship between abiotic and biotic factors, aquatic vegetation, aquatic pollution, source of pollution, major aquatic pollutants and their effect on fishes, causes of pollution and control methods, waste water recycling. Use of aquatic animals in monitoring pollution through bioassays.

Population and Diversity.

14 hrs

Population: Fish population, population density, population structure (year classes), oscillation of population, population fluctuation, abundance, causal factors, population

dynamics, determination of age and growth of fishes, length and weight relationship, recruitment and mortality. **Fish diversity:** Concept of fish diversity, species diversity, genetic diversity, fish diversity crisis in fisheries. **Impact of Dam:** Impact of dam on fish diversity and fish diversity conservation, climatic changes and mitigation.

Conservation and Management of Natural waters: **18 hrs**

Environmental Impact Assessment (EIA): Effects of developmental activities on natural fishery resources, aquatic environment and EIA for mitigation measure. **Fishery and Water Related Acts:** Regulation and control of different types of illegal and unconventional fishing gears used in Nepal for fishery exploitation. **Management of natural migratory fish stock:** Population (fish population dynamics), fish predator and food webs. Existing natural population and fish bio-geographic relation and analysis.

Research Methodology: **36 hrs**

Fish sampling methods for survey of rivers and lakes. (nets, electro-fishing). Field research project and designing. Cataloguing fishes for detail study and field identification. Application of biostatistics in fish and fisheries research. Introduction to research methodology and identification of problem. Objective of research. Research planning, data analysis, interpretation, conclusion, abstracting, literature citation, scientific paper writing. Using various instruments used in fishery works. Fish preservation and identification using keys. Keys related to order, family and species. Study fish taxonomy and international rules of zoological nomenclature. Application of statistical techniques for fisheries research T-test, chi-square test (X^2), contingency table, correlation, regression and analysis of variance.

References

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Central Department of Zoology
Question Models (New Course)
2065

Master Level: Zoo 631
(Fish and Fishery 1st Paper)

Full Marks: 100
Pass Marks: 40
Time: 4.0 Hrs.

Candidates are required to give answers in their own words as far as practicable. The figures in the margin indicate full marks. Illustrate your answers with suitable diagrams wherever necessary.

Group A (Fishery systematics evolution, anatomy and physiology)

Attempt any two questions only:

2x10=20

1. Discuss the process and patterns of evolution in fishes; biochemical techniques and molecular aspects of classification.
2. Write about structure of gills in typical fresh water fishes, counter current mechanism and gas exchange with suitable diagrams.
3. Describe the role of the hormones on the life processes and breeding processes of fish and its impact on aquaculture

Group B (Fishery behaviour and genetics)

Attempt any two questions only:

2x10=20

4. Discuss the reproductive and breeding behaviour in fishes in response to gonadal changes and maturation.
5. Write about the application of polymerase chain reaction techniques in gene cloning for quality improvement of fishes.

6. Discuss about the effects of environmental factors in the biology and migratory behaviour of fishes

Group C

Attempt all questions:

8x5=40

7. What do you understand by international code of zoological nomenclature? Illustrate its significance in zoological nomenclature.
8. Discuss upon modes and types of speciation.
9. Write about the structure and function of weberian ossicles in fishes.
10. Discuss the hypotheses of egg activation for fertilization

Or

What is neurosecretion? Write about its significance in the fish life.

11. Why do fishes show cannibalism? How this behaviour can be avoided for fish management.
12. What is genetic drift? Discuss its implication in fish conservation.
13. What is the impact of inbreeding? Write the importance of selective breeding.
14. What is the application of molecular markers in genetic engineering of fishes?

Or

What do you understand by gene mapping? Discuss briefly about its role in the improvement of fish genetics.

Group D

Attempt all questions:

8x2.5=20

15. What do you understand by DNA Finger Printings?
16. Write about structure of heart in fresh water fishes.
17. What is the role of lateral line system?
18. How the knowledge of fish behaviour used as a tool of fish catching?
19. What is the significance of transgenic fishes in aquaculture?
20. Give your brief opinion for the conservation of gene pool of indigenous fishes for fish security.
21. Discuss hybridization.
22. How do fishes maintain buoyancy in water? Discuss briefly.

Department of Zoology
Question Models (New Course)
2065

Master Level: Zoo 632
(Fish and Fishery 2nd Paper)

Full Marks: 100
Pass Marks: 40
Time: 4.0 Hrs.

Candidates are required to give answers in their own words as far as practicable. The figures in the margin indicate full marks. Illustrate your answers with suitable diagrams wherever necessary.

Group A (Captive Fisheries and aquaculture)

Attempt any two questions only:

2x10=20

1. Discuss scope and economics of Trout (*Oncorhynchus mykiss*) culture in the context of Nepal.
2. Write about the migratory fishes of Nepal and impacts of dams on fish Migration. Also illustrate the different mitigation measures to minimize the affect and conserve native fish stocks.
3. Why polyculture of carp fishes and integrated fish farming systems are more relevant in Nepal in semi-intensive fish culture? Explain the statements for the significance of carp fish production in plain areas of Nepal.

Group B

(Fishery Management, breeding, stock management and improvement)

Attempt any two questions only:

2x10=20

4. Discuss the concept of hatchery design, incubation, hatching and larval rearing units and their role in hatchery development of fish farms.
5. What are different factors requiring specific attention to formulate artificial pellet with appropriate nutrients and stability of feed.
6. Discuss the biochemical composition of raw fish, factors affecting biochemical composition and nutritive value of raw and preserved fishes.

Group C

Attempt all questions:

8x5=40

7. What are traditional and modern fishing gears and methods used in Nepal.
8. Discuss the significance of extensive cage culture in Kulekhani reservoirs.
9. Discuss National policy and legislation of fish farming and constraints for the development of aquaculture.
10. Discuss the scope for shrimp culture in Nepal.

Or

What is homestead kitchen pond fish farming? Illustrate its importance in the livelihood of poor communities.

11. Discuss different factors need consideration in pond engineering and design for pond construction.
12. How present level of fish preservation can be improved during fish transport and stocking.
13. What is the responsibility of fish farm manager to improve water quality, fish health and fish production?
14. How the bacterial diseases of fish can be prevented and controlled in fish farms?

Or

Discuss different modes of fish marketing channels existed in Nepal.

Group D

Attempt all questions:

8x2.5=20

15. What are the different exotic fishes in Nepal? Is it a wise decision to introduce them?

16. What are the existing laws of fish and fisheries? How these laws can be best implemented? Give your ideas.
17. Write about air breathing fishes and their importance in aquaculture.
18. Discuss about ornamental fish farming.
19. Give the significance of liming in fish pond preparation.
20. What is the significance of hypophysation in artificial breeding?
21. Give different symptoms of diseased fishes.
22. How fishery co-operative, society can play significant role to promote fish marketing?

Central Department of Zoology
Question Models (New Course)
2065

Master Level: Zoo 633
(Fish and Fishery 3rd Paper)

Full Marks: 100
Pass Marks: 40
Time: 4.0 Hrs.

Candidates are required to give answers in their own words as far as practicable. The figures in the margin indicate full marks. Illustrate your answers with suitable diagrams wherever necessary.

Group A (Fresh water ecology, population and diversity)

Attempt any two questions only:

2x10=20

1. Discuss different River systems and different systems of river zonation. Also write about different river zonation in reference to Nepal.
2. Discuss the role and importance of water quality parameters like temperature and dissolved oxygen in fisheries. What do you understand by thermal stratification? Discuss its implication on aquatic biodiversity.
3. Discuss population and diversity of fishes. What are different adverse causal factors for fish diversity crisis and how these adverse factors can be minimized in the context of Nepal?

Group B (Conservation, management of natural waters and research methodology)

Attempt any two questions only:

2x10=20

4. What is EIA? What are different procedures and legal aspects for conducting EIA for hydropower project? Discuss mitigation measures to minimize the impact and maintain aquatic biodiversity?

- 5 Discuss different aspects of research methodology and write about the significance of research planning, data analysis and interpretation of data in scientific research study.
- 6 Discuss the application of T-test, correlation and analysis of variance in research study.

Group C

Attempt all questions:

8x5=40

7. Write about ecology and application wetlands like swamps, marshes.
8. What is eutrophication? Discuss casual factors.
9. Write about the significance of BOD and COD.
10. Discuss the difference between primary and secondary productivity. How they are estimated in aquatic ecosystem?

Or

What is waste water recycling? Write about its significance in fish culture.

11. What are the different fish sampling methods in riverine ecosystem?
12. Discuss the importance of predator-prey relationship in fishes in natural ecosystems.
13. Illustrate the role of chi-square test (X^2) test in '2x2' contingency table.
14. Write about cataloguing of fishes for field identification and detail study

Or

What are different related keys to order, family and species used in fish taxonomy? according to international rules of zoological nomenclature.

Group D

Attempt all questions:

8x2.5=20

15. What do you understand by bio-indicator of pollution?
16. Describe different types of lakes on the basis of origin and distribution in Nepal.
17. Write about the role of irrigated paddy fields in fisheries.
18. What is periphyton? Give its significance in aquatic ecosystem.

19. What do you understand by fish bio-geographic relation?
20. Is recruitment of hatchery reared fishes also a mitigation measures in the fish conservation? Give your comments.
21. Discuss the application of biostatistics in fish and fisheries research.
22. What is the significance of Abstracts in scientific paper writing?

Tribhuvan University

Master Level (2 Yrs/IIst Yr)Sc. & Tech.

Full Mark: 100

Zoology 632 (Applied Fishery Management)

Pass Marks: 40

Time : 4 hrs

Model Question (New course, 2065)

Candidates are required to give their answers in their own words as far as practicable.

The figures in the margin indicate full marks.

Illustrate your answers with suitable diagrams wherever necessary.

Group A ()

Attempt any two questions only

2x10=20

1. Discuss the present status of aquaculture development in Nepal.
2. Write an account of symptoms of sickness and defensive devices of fishes against diseases.
3. Review briefly fish culture practices in Nepal.

Group B ()

Attempt any two questions only

2x10=20

4. Give an account of construction, maintenance and bio-engineering of fish ponds in your locality.
5. Describe in detail induced breeding in fishes and add note on the factors influencing it.
6. Enumerate fish predators and their control

Group C

Attempt all questions

8x5=40

7. Review cage culture systems in Nepal.
8. Write an account of fish marketing.
9. Discuss in brief fish co-operatives in Nepal and their role in development.

10. Describe biological factors influencing fish culture.
11. Write an account of fish preservation.

or

Give an account of role of pituitary hormone in fish breeding.

12. Discuss fish hatchery development and its function in Nepal.

or

Describe in brief shrimps culture.

13. Write on account of alliance of prawn and carp culture.
14. Describe in brief integrated fish culture.

Group D

All are compulsory

8x2.5=20

15. Give the very short answers of the following:
 - i. Role of ovaprim in fish breeding.
 - ii. Artificial feed.
 - iii. Cold water fisheries.
 - iv. Fish processing.
 - v. Viral diseases in fish.
 - vi. Polyculture.
 - vii. Fish cum duck culture.
 - viii. Cage culture.

M Sc II Year
Fish and Fisheries
Practical I Paper

Course Number- Zool 634

Course description: Taxonomy, Anatomy and Physiology

1. Collection and identification of different species of fishes from natural habitats.
2. Museum specimens
3. Dissection of some fishes to study: General Anatomy, Respiratory and Accessory Respiratory organs.
4. Dissection of some siluroid and cyprinoid fishes such as *Catla* spp. *Wallago* spp., *Mystus* spp. and Rohu spp. to study Cranial nerves, Weberian ossicles and Internal ear.
5. Permanent mountings: Permanent slide preparation of scales, ampullae of Lorenzini, Respiratory membrane, eggs, hatchlings, fry and fingerlings.
6. Preparation of fish skeleton and osteological study.
7. Microtome preparation of gonads and different organ tissues.
8. Study of hill stream modifications *Glyptosternum* sp. *Pseudoecheinus sulcatus*, *Schizothorax* sp. and *Garra* sp.
9. Report writing after field visit to different fish farms (Collection of information about inbreeding and genetic analysis of common carp pedigree, excursion to Pokhara and Kali Gandaki fish farms to study about Mahaseer pedigree).

Model Questions
Fish and Fisheries
Practical I Paper

Course No. - Zool.634

Full Marks- 50

Pass Marks- 20

Course Contents: Taxonomy, Anatomy, Physiology and Behavior

Time – 4hrs

Attempt all questions

1. Dissect the animal provided so as to expose its cranial nerves and leave a well-labeled diagram of the same- - - - - (10)

2. Expose Accessory Respiratory Organ of *Clarias* sp. and leave a well labeled diagram- (4)

2. Prepare a permanent slide of scale of *Anabas* sp. Comment and draw a well labeled diagram-(4)

4. Identify fishes provided upto species with classification and characters- (6)

OR

Write down hill stream modifications of the fishes provided with well labeled diagrams

5. Identify and comment upon the given spots 1-6- - - - (6)

6. Viva Voce- - - - - (6)

7. Class Record, Collection and report preparation--- - (6+4+4)

M Sc II Year
Fish and Fisheries
Practical II Paper

Course Number- Zool 635

Course description: Applied Fisheries Management and Fresh water Ecology

1. Limnology: Measurement of temperature, pH, dissolved oxygen, free carbondioxide, alkalinity, acidity, hardness, minerals, specific conductivity, dissolved solids.
2. Sampling preservation and identification of planktons and macro invertebrates, methods for qualitative and quantitative estimation of planktons and assessment of primary productivity by light and dark bottle method.
3. Study of the impact of damming on riverine fisheries and fish migration in Sunkosi and Kali-Gandaki rivers
4. Preparation of bathymetric map of water body.
5. Introduction of different fishing gears using models.
6. Study of fecundity of some fresh water fishes.
7. Determination of age and growth of fishes.
8. Fish nutrition: Feed composition/formulation
9. Fish diseases: study of causative agents, symptoms and preservation methods for common diseases and parasites of carps and rainbow trout.

10. Pond engineering: Study about layout, design and construction of fish ponds for carps and raceways for rainbow trout.

11. Report preparation on the basis of field visit to different fish farms (Focus should be given on breeding techniques both artificial and semi artificial, types of ponds etc.)

Model Questions
Fish and Fisheries
II Paper

Full Marks- 50
Pass Marks- 20
Time – 4hrs

Course No. - Zool.635

Course Contents: Applied Fisheries Management and Fresh water Ecology

Attempt all questions

1. Estimate Dissolved Oxygen of the given water sample- - - - - (12)
2. Enumerate planktons in the given water sample- - - - - (6)
3. Calculate the composition of fish feed formulated with 40% protein from given ingredients-(8)

Ingredients	Protein Level (%)
Wheat bran	8.5
Rice bran	8.0
Fish meal	52.0
Soybean	37.5
Ground nut oil cake	43.5
Silkworm Pupae	43.8
Maize	9.5

4. Calculate length and weight relationship and condition factor and plot graph- - - - (6)

Length(cm)	Weight(gm)
12	200
18	500
10	200
20	700
30	1250
40	1400
15	650
18	600

OR

Calculate GSI and Fecundity of the fish data provided

5. Viva Voce- - - - - (6)
6. Class record and report preparation- - - - - (8+4)