

Course Curriculum, Syllabus & Structure

M.Sc. Ornithology & Conservation Biology

(Affiliated to Saurashtra University, Rajkot, Gujarat)

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Salim Ali Centre for Ornithology and Natural History (SACON)

(A Centre of Excellence under the Ministry of Environment, Forest & Climate Change, Govt. of India)

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1. List of Core & Supplementary Papers

SEMESTER-I

Core papers:

OCB-101. ORNITHOLOGY-I
OCB-102. INDIAN WILDLIFE & FORESTRY
OCB-103. FUNDAMENTALS OF ECOLOGY & BIOGEOGRAPHY
OCB-104. RESEARCH METHODOLOGY & BIostatISTICS

Supplementaries:

OCB-105. ELECTIVE PAPER-I
OCB-106. TOUR ASSIGNMENTS & JOURNAL-I

SEMESTER-II

Core papers:

OCB-201. ORNITHOLOGY-II
OCB-202. ANIMAL BEHAVIOUR & EVOLUTIONARY ECOLOGY
OCB-203. TERRESTRIAL ECOLOGY
OCB-204. AQUATIC & MARINE ECOLOGY
OCB-205. CONSERVATION BIOLOGY-I

Supplementaries:

OCB-206. ELECTIVE PAPER-II
OCB-207. TOUR ASSIGNMENTS & JOURNAL-II
OCB-208. RESEARCH DESIGN & COMMUNICATION WORKSHOP

SEMESTER-III

Core papers:

OCB-301. CONSERVATION BIOLOGY-II
OCB-302. APPLIED ORNITHOLOGY
OCB-303. WILDLIFE HEALTH & ZOO SCIENCE
OCB-304. WILDLIFE MANAGEMENT & POLICY

Supplementaries:

OCB-305. TOUR ASSIGNMENTS & JOURNAL-III

SEMESTER-IV

Core papers:

OCB-401. Dissertation & Viva-voce

2. Credit Structure of Coursework: Papers & Modules

[Notes: 1 credit is approximately 4-6 hours of class-hours (excluding extramural sessions like tours, field visits, library assignments, literature review, etc). Maximum credit for a Core Paper is 5. As per UGC guidelines, one semester shall be of a minimum of 90 class-hours]

Core/Supplementary Paper	Total Credits	Module	Module Credits	Module Coordinators
SEMESTER-I				
OCB-101. ORNITHOLOGY-I	5	1. Avian Evolution, Systematics, & Biogeography	2	
		2. Form & Function in Birds	2	
		3. Breeding Strategies in Birds	1	
OCB-102. INDIAN WILDLIFE & FORESTRY	5	4. Vegetation Science & Forestry	2	
		5. Mammalogy	2	
		6. Herpetology	0.5	
		7. Ichthyology & Invertebrate Biology	0.5	
OCB-103. FUNDAMENTALS OF ECOLOGY & BIOGEOGRAPHY	5	8. Population Ecology	2	
		9. Community Ecology	2	
		10. Biogeography & Macroecology	1	
OCB-104. RESEARCH METHODOLOGY & BIOSTATISTICS	5	11. Biostatistics	4	
		12. Instrumentation & Analytical Techniques in Environmental Science	1	
OCB-105. ELECTIVE PAPER-I	1		1	
OCB-106. TOUR ASSIGNMENTS & JOURNAL-I	1		1	
SEMESTER-II				
OCB-201. ORNITHOLOGY-II	5	13. Ecology of Bird Populations & Communities	2	
		14. Avian Endocrinology & Chronobiology	2	
		15. Bird Migration	1	
OCB-202. ANIMAL BEHAVIOUR & EVOLUTIONARY ECOLOGY	3	16. Behavioural Ecology	2	
		17. Evolutionary Ecology	1	
OCB-203. TERRESTRIAL ECOLOGY	5	18. Habitat Ecology	2	
		19. Landscape Ecology	2	
		20. Geographical Information Systems & Remote Sensing	1	
OCB-204. AQUATIC & MARINE ECOLOGY	3	21. Wetland Ecology & Management	2	
		22. Coastal & Marine Ecology	1	

Core/Supplementary Paper	Total Credits	Module	Module Credits	Module Coordinators
OCB-205. CONSERVATION BIOLOGY-I	4	23. Principles of Conservation Biology	2	
		24. Conservation Genetics	2	
OCB-206. ELECTIVE PAPER-II	1		1	
OCB-207. TOUR ASSIGNMENTS & JOURNAL-II	1		1	
OCB-208. RESEARCH DESIGN & COMMUNICATION WORKSHOP	1		1	
SEMESTER-III				
OCB-301. CONSERVATION BIOLOGY-II	3	25. Climate Change Ecology	1	
		26. Ecotoxicology	2	
OCB-302. APPLIED ORNITHOLOGY	4	27. Economic & Agricultural Ornithology	2	
		28. Bird Conservation & Population Management	1	
		29. Bird Census & Population Monitoring	1	
OCB-303. WILDLIFE HEALTH & ZOO SCIENCE	2	30. Wildlife Health & Animal Management	1	
		31. Zoo Science & Conservation Breeding	1	
OCB-304. WILDLIFE MANAGEMENT & POLICY	5	32. Principles of Wildlife Management	3	
		33. Human-Wildlife Conflicts & Management	2	
		34. Environmental Impact Assessment	1	
OCB-305. TOUR ASSIGNMENTS & JOURNAL-III	1		1	
SEMESTER-IV				
OCB-401. Dissertation & Viva-voce	20			

3. Semester-wise Distribution of Marks

Core/Supplementary Paper	Internal Marks*	Examination Marks	Total Marks
SEMESTER-I			
OCB-101. ORNITHOLOGY-I	30	70	100
OCB-102. INDIAN WILDLIFE & FORESTRY	30	70	100
OCB-103. FUNDAMENTALS OF ECOLOGY & BIOGEOGRAPHY	30	70	100
OCB-104. RESEARCH METHODOLOGY & BIostatISTICS	30	70	100
OCB-105. ELECTIVE PAPER-I			50
OCB-106. TOUR ASSIGNMENTS & JOURNAL-I			50
SEMESTER-II			
OCB-201. ORNITHOLOGY-II	30	70	100
OCB-202. ANIMAL BEHAVIOUR & EVOLUTIONARY ECOLOGY	30	70	100
OCB-203. TERRESTRIAL ECOLOGY	30	70	100
OCB-204. AQUATIC & MARINE ECOLOGY	30	70	100
OCB-205. CONSERVATION BIOLOGY-I	30	70	100
OCB-206. ELECTIVE PAPER-II			50
OCB-207. TOUR ASSIGNMENTS & JOURNAL-II			50
OCB-208. RESEARCH DESIGN & COMMUNICATION WORKSHOP			50
SEMESTER-III			
OCB-301. CONSERVATION BIOLOGY-II	30	70	100
OCB-302. APPLIED ORNITHOLOGY	30	70	100
OCB-303. WILDLIFE HEALTH & ZOO SCIENCE	30	70	100
OCB-304. WILDLIFE MANAGEMENT & POLICY	30	70	100
OCB-305. TOUR ASSIGNMENTS & JOURNAL-III			50
SEMSTER-IV			
OCB-401. Dissertation & Viva-voce	350 (Dissertation)	50 (Viva-voce)	400
Total Marks			2000

* Internal marks will be computed from all the constituent modules of the Core Paper. Each module will have the following assessment components: MCQ-based Written Quiz (10), Practicals (10), and Term Papers/Assignments/Seminars (10). Module Coordinators will conduct these assessments.

4. Detailed Syllabus

M.Sc. (Ornithology & Conservation Biology)

[Affiliated to Saurashtra University, Rajkot under Choice Based Credit System]

SEMESTER-I

OCB-101. ORNITHOLOGY-I

Module 1. Avian Evolution, Systematics, & Biogeography

Origin of birds – Comparative study of birds & reptiles - Fossil history - Archeopteryx – Hypotheses on avian origin: Theropods versus Archosaurs – Evidences for and against theropod origin of birds – Evolution of flight in birds: arboreal versus cursorial theory – Geological events in the history of avian evolution and radiation – KT boundary and continental shift - Diversification of modern birds – Adaptive radiation & speciation in birds.

Avian systematics – Principles of animal taxonomy – Homology vs homoplasy - Sympleiomorphy vs synapomorphy - Phylogenetic relationships [monophyly, paraphyly, & polyphyly] – Major schools of avian classification: evolutionary, phenetic, & phylogenetic/cladistic – Species concepts: Biological versus Phylogenetic Species - Species problems in avian classification: plasticity, polymorphism, cryptic species, character convergence, hybridization, & ring species - Brief history of classification of birds – Major authorities: Wetmore, Peters, and Sibley & Monroe – Modern classifications – Concepts of molecular systematics – Phylogeny trees: interpretation - An introduction to diversity and distribution of birds of India.

Biogeography of birds – Dispersal vs vicariance – Modes of speciation in Indian birds: allopatric, parapatric, & sympatric – Refugia & relict species – Zoogeographical affinities of Indian avifauna – Disjunct distribution of Indo-Malayan fauna in Eastern Himalaya and the Western Ghats – Hora's Satpura Hypothesis – Dilger's Brij hypothesis – Endemism in Indian avifauna – Endemic Bird Areas of India - Ornithogeography of Andaman & Nicobar Islands and Sri Lanka.

Practicals: Field identification of birds; group discussions on key papers in origin and evolution of birds; study of distribution maps of Indian avifauna and biogeographical 'anomalies'; exercise in reconciling molecular evidences with morphological differences over species limits in Indian birds; exercise in reading and interpreting molecular phylogenies of birds and reconstruction of phylogenetic relationships between bird taxa .

Module 2. Form & Function in Birds

Body plan in birds – Topography: head, neck, trunk, wings, tail, bill, eyes, feet – Feathers: structure, types, colour, & function – Feather-tracts & pterylosis - Ptilochronology – Moults & plumages – Typology – Annual moult cycles & moulting strategies – Moult scores – Feather maintenance & oil gland – Avian flight: forms, mechanisms, & energetics.

Avian anatomy – Skeletal system: skull, vertebral column, sternum, and pectoral & pelvic girdles – Muscular system: pelvic and wing musculature – Respiratory system: nares, pharynx, larynx, trachea and syrinx, lungs and air sacs – Circulatory system: heart, arterial and venous systems – Digestive system: tongue, alimentary canal, gizzard, intestinal processes – Urogenital system: excretory organs, reproductive organs, copulation – Gametes: functional structure & adaptations in avian sperms and eggs.

Senses & nervous system in birds – Central and peripheral nervous systems – Sense organs – Avian eye and vision – Ears & auditory sense – Echolocation in birds – Taste and olfactory sense – Tactile sense in birds – Thermoregulation in birds - Cognition & intelligence in birds: associative faculty, spatial and temporal perception, tool use, & self recognition.

Vocalization in birds – Structural mechanism & syringeal muscle – Songs & calls – Measures - Song development – Context and communication – Geographical variations & dialects - Song repertoire size & function – Dawn chorus - Duetting - Mimicry – Flight song – Non-vocal/mechanical sounds.

Unique functional adaptations in birds: temperature regulation of mound-nests in megapodes, salt-excretion in seabirds, milk secretion in pigeons, torpor in nightjars, saliva-nests of swifts.

Practicals: Laboratory examination of birds and their body parts; microscopic examination of feathers and their micro-structures to aid identification of taxa; exercise in computing moult scores in wild birds; recording of bird-calls and analysis of their properties.

Module 3. Breeding Strategies in Birds

Annual breeding cycle & photoperiodism in birds – Territoriality – Pair bonds & courtship display – Mate choice & copulatory behaviour - Bird nests: evolution & functions – Nesting substrates & nest-site selection in birds – Nest types – Nesting materials – Nest lining - Role of sexes in nest construction – Nest reuse & takeover – Avian eggs: size, structure, shape, colour, & texture – Egg laying in birds: determinate & indeterminate layers - Clutch size – Factors influencing clutch size & optimality – Incubation period & brood patch – Incubation behaviour - Role of sexes in incubation – Unique nesting behaviours: megapodes, edible-nest swiftlets, hornbills, & weavers - Hatching asynchrony – Bet hedging strategies in breeding birds - Nidicolous & nidifugous hatchlings – Parental care: feeding, defence, nest sanitation – Post-fledging dispersal.

Mating systems in birds: monogamy, polygyny, & polyandry – Lekking behaviour & arena birds – Egg dumping & brood parasitism – Adaptations of brood-parasitic birds – Host-parasite interactions – Communal/cooperative breeding in birds – Kin selection & altruism – Ecological constraints & cooperative breeding – Colonial breeding systems in birds: ecological and evolutionary factors – Information centre hypothesis - Heronries: composition, structure, & seasonal dynamics.

Practicals: Field observations of bird nests and nesting behaviour; mapping of bird territories; group-discussion on various hypotheses on breeding strategies in birds; field visits to heronries to quantify their structure and composition; group-discussions.

OCB-102. INDIAN WILDLIFE & FORESTRY

Module 4. Vegetation Science & Forestry

Evolution of plants – Principles of plant taxonomy – Major angiosperm families of Indian forests and their key flora – Identification of forest plants – Diversity and distribution of forest flora of India – Forest types of India – Major systems of vegetation classification in India – Vegetation surveys and sampling techniques – Plant conservation strategies (*in-situ* and *ex-situ*).

Brief history of forestry in India – Principles of forest conservation and management – Silviculture and agro-forestry – Forest genetics & tree breeding – Forest ecology and environment – Forest products & natural resource management – Forest governance in India.

Practicals: Field identification of forest flora & herbarium preparation; field exercises for vegetation surveys and sampling; exposure to forest nursery techniques; study of collection of minor forest products; exposure to forestry operations.

Module 5. Mammalogy

Origin, evolution, and radiation of mammals – Classification and taxonomy – Morphological and physiological adaptations – Thermoregulation and metabolism – Body size-mediated responses to environmental factors – Life-history strategies – Home range and movements – Foraging ecology and nutrition – Competition for resources – Population regulation – Mammalian behavior – Social organization in mammals – Reproduction in mammals – Threatened mammals of India and their conservation.

Practicals: Field identification of mammal signs and habitat use; study of mammal skins and their derivatives including horns and antlers, dentition in mammals, skull identification and anatomy; field assessment of animal age and health.

Module 6. Herpetology

Evolution of amphibians and reptiles – Systematics and biogeography of herpetofauna – Diversity, distribution, and endemism in Indian herpetofauna: amphibians (frogs, salamanders, and caecilians) and reptiles (freshwater and sea turtles, crocodylians, lizards, and snakes) – Morphological and physiological adaptations – Thermoregulation and behavioural strategies of herpetofauna in cold environments – Temperature-dependent sex determination – Population regulation – Declining populations of amphibians and other major conservation issues – Population surveys and census techniques for reptiles and amphibians.

Practicals: Field identification of different groups of herpetofauna; capture and marking techniques; field techniques for herpetofaunal surveys and population estimation.

Module 7. Ichthyology & Invertebrate Biology

Evolution and radiation of fishes – Fish classification and major groups of freshwater and marine fishes of India – Zoogeography of Indian freshwater fishes – Biology of fishes and their adaptations – Buoyancy and thermal regulation – Movement ecology of fishes – Fish communities, competition, and resource use – Economic importance of fishes – Species invasions - Overharvesting and other threats to fish populations.

Introduction to insect and invertebrate diversity of India – Classification and key biological features of major invertebrate taxa – Ecology of invertebrates – Host-parasite and prey-predator interactions – Population regulation – Insects, spiders, and other invertebrates as key indicator taxa in forest ecosystems – Role of insects in ecosystem functioning and services - Major insect pests of forest trees – Methods to study and survey terrestrial invertebrates - Ecology of marine invertebrates including corals, sponges, and mollusks – Importance of coral reefs as keystone taxa in marine ecosystem.

Practicals: Field identification of fishes, fish sampling and marking techniques; morphometric measurement of fishes, and field methods to study fish ecology; field identification of major groups of invertebrate taxa; sampling techniques of insects and invertebrates; collection and preservation techniques; rapid biodiversity surveys for assessing invertebrate diversity.

OCB-103. FUNDAMENTALS OF ECOLOGY & BIOGEOGRAPHY

Module 8. Population Ecology

Unitary & modular organisms – Population abundance, density, & distribution – r & K selection – Allometry – Carrying capacity - Sex ratios & age structure of populations – Spatio-temporal processes of dispersal, emigration, and immigration – Demography and life-history parameters – Birth rate, mortality, survival, life-tables and survivorship curve – Fecundity and population growth rate – Demographic and environmental stochasticity -Population extinctions – Population Viability Analysis – Metapopulations - Population regulation – Density-dependent factors – Competition & coexistence – Fundamental and realized niche – Lotka-Volterra models – Prey-predator relationships – Plant-herbivore interactions– Density compensation in species populations – Optimal foraging theory – Parasitism and mutualism.

Population estimation – Distance-based sampling techniques – Mark-recapture framework for open and closed populations – Bayesian approaches to abundance estimation – Occupancy estimation and modeling for rare and elusive populations – Population indices.

Practicals: Computation of demographic parameters, population growth rate, and extinction probability using software (like RAMAS and Vortex); Population Viability Analysis; population estimation exercises in the field and lab using programs like DISTANCE, MARK, and PRESENCE.

Module 9. Community Ecology

Communities and assemblages – Dominant views of communities – Community attributes – Species composition, richness, diversity, evenness, and dominance – Spatial scale and patchiness – Food web of communities – Community structure and organization in space and time – Factors influencing species diversity and community structure – Competition, ecological guilds, niche, and resource partitioning – Theory of limiting similarity – Ecological sorting – Ecomorphology of communities: character ratios, displacement, release, and convergence – Ecological succession – Resource and disturbance gradients – Diversity, productivity, and stability in ecological communities – Species abundance-distribution models – Community saturation - Assembly rules – Null models – Community nestedness – Community similarity - Habitat selection in ecological communities.

Practicals: Simulation exercises to compute various community attributes in response to disturbance and other environmental gradients; field assignments on collection of data on plant/animal communities; numerical analysis of ecological communities.

Module 10. Biogeography & Macroecology

Historical biogeography – Geographical and ecological variations & natural selection – Biogeographical processes: dispersal and vicariance – Continental drift – Routes and agents of dispersal - Speciation: allopatry, peripatry, parapatry, stasipatry, and sympatry – Species diversification – Adaptive and non-adaptive radiations – Convergent and parallel evolution – Species extinctions: evolutionary factors – Species distributions – Zoogeographical and floral regions of the world – Biogeographical importance of Wallacea – Biogeographic classification of India – Areography: range size and shape – Species distributions: endemism, cosmopolitan & parochial distributions, continuous vs disjunct distributions, relict species and refugia – Island biogeography theory.

Ecological biogeography (Macroecology) – Large-scale patterns in species richness and diversity – Species-area relationships – Environmental determinants of species diversity – Species-energy theory – Water-energy dynamics hypothesis for species richness - Local and regional species richness – Latitudinal trends in species richness – Rapaport's rule – Elevational patterns in species diversity & mid-domain effect– Determinants of species range size – Relationships between body size, range size, and abundance – Ecogeographic rules: Bergmann's, Allen's, Gloger's, Jordan's, and Thorson's rules.

Practicals: Lab exercise to map distribution patterns of key flora and fauna to assess biogeographic classification of India; lab assignments to test ecogeographic rules from secondary data.

OCB-104. RESEARCH METHODOLOGY & BIOSTATISTICS

Module 11. Biostatistics

Introduction to principles of modern scientific inquiry – Descriptive, exploratory, and inferential statistics – Populations, samples, and sampling units – Random sampling – Scales of measurements – Measurement errors: bias, accuracy, and precision – Measures of central tendency: mean, mode, and

median – Measures of data variability: variance, standard deviation, standard error, coefficient of variation, & confidence intervals – Graphical representation of data – Data transformations – Probability theory – Major probability distributions: normal, binomial, negative binomial, Poisson distributions – Type I & II errors – Hypothesis testing – t, F, and Chi-square distributions – One tailed & two-tailed tests – Sample size and effect size – Statistical power – Parametric and non-parametric statistics – One-sample tests – Two independent samples – K independent samples (ANOVA) – Two related samples – K related samples – Non-parametric tests (incl. Chi-square and contingency tables) – Correlation and regression analyses.

Practicals: Analysis of ecological data using statistical software (like R, SPSS, and PAST) in the computer lab.

Module 12. Instrumentation & Analytical Techniques in Environmental Science

Basic concepts of analytical chemistry – Maintaining quality in instrumentation – Sample preparation: weighing and sampling – Trace analysis – Autoradiography - Radionuclides and radiotracers in environmental studies – Principles of chromatography – Gas, liquid, and thin layer chromatography – Osmometry and respirometer - Electrophoresis – Spectroscopy (UV, IR, & NMR spectroscopy) – Mass spectrometry – Atomic spectroscopy – Flame photometry and fluorimetry -Thermal analysis and calorimetry – Optical microscopy – Electron microscopy – DNA extraction and amplification – DNA replication and synthesis of primers – Satellite markers - PCR & gel documentation.

Practicals: Lab analysis of water, soil, and organisms using instrumentation facilities; nutritional analysis of food plants of herbivores and frugivores; DNA extraction, preservation and amplification from biological samples.

OCB-105. ELECTIVE PAPER -I

[Each student shall take ONE elective paper from the following options, provided the paper is opted by certain minimum number of students. List not exhaustive; more topics to be added based on representations from teaching faculty, subject to approval]:

1. History of Indian Ornithology
2. Acoustic Ornithology: Study of Avian Vocalizations
3. Ecomorphology: Principles and Analytical Approaches
4. Primate Behaviour & Ecology
5. Ecology & Conservation of Carnivores
6. Montane Grasslands: Ecology & Management
7. Tropical Savannas: Ecology & Management

OCB-106. TOUR ASSIGNMENTS & JOURNAL -I

SEMESTER-II

OCB-201. ORNITHOLOGY-II

Module 13. Ecology of Bird Populations & Communities

Bird populations & social organizations – Spatio-temporal variations in population density of birds - Density independent and density dependent factors – Avian demography: age structure, senescence & longevity – Delayed plumage maturation – Sex ratios in population – Allocation of sexes – Manipulation of sex ratios in bird populations – Life-history parameters – Allometry & scaling - Clutch size & population recruitment rate – Adaptive changes in population abundance – Rarity in birds: biological and ecological drivers - Allee effect – Introduced birds & their impacts on native bird populations – Population genetics of birds – Effective population size – Carrying capacity - Population limitation in birds: food, nest site, competition, predation, parasites & pathogens, weather, & human activities – Population irruption & regulation in birds.

Bird communities & assemblages – Species diversity & richness – Species-area relationships – Latitudinal and altitudinal gradients in bird species diversity - Species turnover – Species abundance & dominance – Saturation of bird communities - Assembly rules & community composition – Niche theory & resource utilization – Niche breadth & overlap – Competition: interference & exploitation – Habitat selection in bird communities - Avian guilds – Ecomorphological patterns of bird communities: character ratios, character displacement, & character convergence – Case studies of Galapagos finches and Hawaiian honeycreepers - Density compensation & character release – Species interactions in bird communities: commensalism, mutualism, parasitism – Mixed species foraging flocks of insectivorous birds.

Practicals: Simulation exercises in computing demographic parameters of bird populations; computation of bird population size and carrying capacity; field exercise to collect data on resource use by competing bird species and calculation of niche overlap; field studies on mixed species flocks of insectivorous birds and their structure and composition.

Module 14. Avian Endocrinology & Chronobiology

Behavioural endocrinology – Avian life-cycles & hormonal mechanisms – The pineal gland & melatonin - Circadian rhythms and photoperiodism in birds – Avian sleep cycles - Hormonal regulation of songs in birds: steroid-melatonin interactions – Hypothalamus & pituitary gland – Functional roles of gonadotropins, thyrotropins, & growth hormones – Prolactin & ACTH – Thyroid glands – HPT Axis & control of metabolism – Development and differentiation of gonads – Role of thyroid hormones in hatching and moulting – Hormonal control of egg-size variations in birds – Hormonal regulation of growth and development in birds - Functions of parathyroids, calcitonin, & vitamin D - Adrenals & corticosteroids – HPP Axis - Hormonal responses of birds to environmental and physiological stress.

Practicals: Demonstration of laboratory techniques in avian endocrinology; visit to chronobiology laboratory and instrumentation facility.

Module 15. Bird Migration

History of bird migration studies – Evolution of migratory behaviour in birds – Types of migration: local, latitudinal, longitudinal, & altitudinal - Proximate and ultimate factors – Migratory syndrome in birds: morphological, physiological, ecological, and behavioural traits – Nocturnal & diurnal migration – Solitary & flock migration.

Physiological aspects of migration – Migratory restlessness - Circadian and circannual rhythms in birds – Biological clocks - Photoperiodism – Endocrine and neural mechanism – Metabolic adaptations – Diet and nutrition in migratory birds - Fat deposition – Thermoregulation and water balance – Flight distance, speed, & altitude – Behavioural adaptations – Formation flight & energy conservation - Migratory stopovers: duration, frequency, & selection – Migration barriers – Impacts of weather phenomena on migration – Vagrancy – Orientation & navigation in migratory birds: types, accuracy, and physiological mechanisms – Sensory basis for orientation - Magnetic compass theory for navigation – Mapping & landmarks – Influence of external environment on navigation – Major migratory flyways.

Migratory ecology of birds – Latitudinal trends – Foraging ecology - Habitat selection in stopover and winter quarters – Comparison of breeding and wintering sites – Moulting patterns in migratory birds – Molt sites in summer quarters – Natal dispersal & dispersive migration - Migration phenology - Arrival and departure time – Phenological differences between sexes and age classes – Site fidelity & territoriality in winter quarters – Food supply and competition - Body size and dominance - Phenomenon of oversummering – Irruptive migration.

Threats to migratory bird populations – Habitat degradation & loss, poaching & hunting, predation by domestic dogs and cats, collisions with man-made structures like windmills and power lines, pollution & chemical contamination, diseases, & natural disasters - Impacts of global climate change on migration phenology and bird populations.

Practicals: Field visits to major sites for migrant birds – both wetlands and forests; field exercise in censusing and monitoring of migrant birds; analysis of eBird data on migration phenology of common migratory birds of India.

OCB-202. ANIMAL BEHAVIOUR & EVOLUTIONARY ECOLOGY

Module 16. Behavioural Ecology

Genes, natural selection and behavior – Ultimate and proximate causes – Nature versus nurture debate – Behavioural mechanisms: neurons & hormones – Feeding behavior & optimality models – Antipredation strategies – Prey & predators: co-evolutionary arms race – Brood parasitism in birds – Evolution of communication and signaling in animals - Sexual selection & mating systems – Cooperative breeding – Alternative breeding strategies - Evolution of parental care – Ecology of group-living and coloniality – Information centre hypothesis – Costs and benefits of sociality – Selfishness, altruism & cooperation – Individual and inclusive fitness.

Hypothesis testing in behavioural studies - Behavioural sampling – Behavioural states and events – Ethograms & time-activity budgets.

Practicals: Field exercises in animal behaviour studies and observations,; focal animal sampling and instantaneous scan sampling; field preparation of ethograms and time-activity budgets; animal marking/radio-telemetry exercises to collect data on animal movements and behaviour.

Module 17. Evolutionary Ecology

Introduction to premises of evolutionary ecology –Major transitional events in evolution of organisms – Multiple, independent origin of flight in animals – Breeding strategies: semelparity to iteroparity & age at maturity – Scaling laws in evolutionary ecology – Allometry, longevity, and metabolic rate - Origin and evolution of sex – Sex ratios – Sex allocation and determination- Kin selection and group selection – Adaptations – Red-queen hypothesis – Critique of adaptationist approaches – Ecological generalists & specialists: evolutionary perspectives – Species interactions: mutualism, parasitism, commensalism, amensalism, neutralism, & symbiosis – Chemical ecology – Evolution of toxins & venoms in plants and animals.

Practicals: Group discussion of foundation papers in evolutionary ecology; group-assignments on developing testable hypotheses from predictions of evolutionary phenomena.

OCB-203. TERRESTRIAL ECOLOGY

Module 18. Habitat Ecology

Habitat concepts – Biotic and abiotic components of habitats – Scale issue – Macro- and micro-habitats – Habitat structure – Vertical and horizontal heterogeneity – Floristics & physiognomy - Habitat edges, ecotones, and interiors – Habitat patches & corridors – Habitat quality – Factors affecting habitat quality – Habitat suitability indices and measurements – Habitat use, selection and preference – Environmental perturbations and wildlife habitats: fire, flood, drought, herbivory, and diseases – Habitat degradation and fragmentation – Monitoring of habitats – Habitat surveys and mapping – Ecology of major wildlife habitats: forests, grasslands, deserts, wetlands, and coastal landforms – Biology of unique habitats: caves, tree-holes, subterranean burrows, termite mounds, etc.

Practicals: Field exercises to measure and evaluate habitat quality in both terrestrial and aquatic ecosystems; computation of habitat suitability indices for select herbivores and terrestrial fauna; field visits to assess habitat fragmentation and degradation.

Module 19. Landscape Ecology

Landscape concepts – Spatial scope and scale – Hierarchical framework – Landscape elements & patterns – Landscape metrics: quantification and applications – Neutral models of landscape patterns – Fractals – Influences of land use patterns on landscape integrity – Human disturbances and landscape

structure – Landscape equilibrium – Spatial heterogeneity, wildlife populations, and landscape connectivity – Fragmentation – Landscape species – Landscape genetics – Analysis of landscape data: spatial statistics & autocorrelation – Landscape management: issues, prospects, and case-studies.

Practicals: Computation of landscape metrics and parameters using FRAGSTATS; lab exercise on analysis of landscape data using spatial statistics software (SAM, ArcGIS, etc); analysis of meta-populations using RAMAS GIS.

Module 20. Geographical Information Systems & Remote Sensing

Nature of geospatial data – Fundamentals of GIS, cartography, & mapping – GPS technology - Coordinate systems and map projections – Vector and raster data – Polygons, topology, & DEMS – Geometric transformations – Errors in spatial data: sources, quantification, and rectification – Metadata and attributes of spatial information – Analysis, interpretation, & visualization of spatial data – Terrain mapping and analysis – Spatial interpolation – GIS models and modeling: binary, index, and process models – Applications of GIS in environmental studies – Spatial decision support systems for forest, biodiversity, and PA management – GIS & land management databases – Free and Open Source Software in GIS – Mobile GIS applications.

Remote sensing: principles & methods – Aerial photography – Aerial sensor imagery – Satellite sensor imagery – High resolution imagery - Image processing & interpretations - Georectification & radiometric correction - Applications of remote sensing in deriving environmental and land cover data - Free and Open Source Software in RS.

Practicals: Developing spatial databases and digitization of topographical maps; lab exercise in mapping and spatial data analysis in GIS software (like ArcGIS, QGIS, & GRASS); lab exercise in extraction of layers from satellite imageries using image analyzer software (like ERDAS Imagine); classification of land cover and land use types from RS imageries; use of mobile GIS applications to collect real time spatial data.

OCB-204. AQUATIC & MARINE ECOLOGY

Module 21. Wetland Ecology & Management

Wetlands: definition, concepts, & functions – Wetland hydrology – Seasonality – Wetland nutrient cycles & buffers – Carbon sequestration in wetlands – Biological adaptations to wetland ecosystems – Coastal wetlands – Mangroves & coral reefs – Intertidal communities – Inland wetlands – Freshwater lentic and riverine systems – Wetland flora and fauna –Wetland communities, zonation, and succession – Classification, inventory, and delineation of wetlands – Primary productivity of wetlands– Biodiversity and ecosystem values of wetlands – Valuation of wetland ecosystem functions and services – Human impacts and management of wetlands – Factors influencing wetland properties: hydrology, fertility, disturbance, competition, herbivory, and sedimentation – Wetland restoration – Wetland conservation and management – Ramsar Convention – International agencies in wetland conservation – Indian laws and policies on wetland management.

Practicals: Field exercise in wetland mapping, water and sediment sampling, sampling of benthic fauna and planktons; lab analysis of water and sediment properties; estimation of primary productivity; quantification of benthic fauna and planktons; wetland surveys to measure floral and faunal diversity.

Module 22. Coastal & Marine Ecology

Geomorphology of coastal environment – Form and function – Continental shelf & neritic zone – Biota of neritic province: planktons – Ecology & adaptations of zoo- and phytoplanktons – Productivity – Sediments – Seagrasses & seagrass communities – Benthos: types, diversity, & spatial distribution – Bioturbation - Intertidal zone: rocky, sandy, and muddy – Physical features of rocky coasts & their biota – Coastal sand-dunes: formation and dynamics – Mudflats – Brackish water environment & salt marshes: succession & zonation – Mangroves: community succession & ecology – Estuaries: types, physical & chemical features, sedimentation, and productivity - Food web in estuarine biota - Coral reefs: classification and types – Reef morphology & zonation – Nutrition, calcification, & growth – Species and community interactions in reefs.

Oceans: extent, depth, & ecosystem properties – Ocean currents and their role in marine ecology – Biota of marine environment & their classification – Marine planktons – Quantification of marine environment and sampling of marine organisms – Seawater properties & habitat characteristics – Primary productivity of oceans – Natural perturbations - Deep sea ecosystem & adaptations – benthos of deep-sea waters.

Conservation of coastal and marine environments – Pollution & degradation of coasts – Coastal industrialization – Fouling – Recreation & tourism – Impacts of oil-spill – Extraction of marine resources – Overfishing – Effects of fisheries and aquaculture – Marine pollution – Climate change & sea water rise – Impacts on coastal and marine biodiversity – Coastal Zone Regulation & marine protected areas.

Practicals: Field visits to coastal and marine protected areas; visits to coastal sites where industrial and infrastructural development works are under way; laboratory analysis of physical and chemical properties of sea water; quantification of marine planktons and benthic fauna.

OCB-205. CONSERVATION BIOLOGY-I

Module 23. Principles of Conservation Biology

Conservation biology as a crisis discipline – Foundations of conservation biology – Wildlife conservation versus preservation – Values of conserving biodiversity - Conservation ethics – Units of conservation: genes, individuals, populations, communities, & biomes – Species diversity – Surrogates in conservation biology: flagship species, umbrella species, keystone species, indicator species, and landscape species – Rarity: typology, ecological correlates, and conservation priorities – Threats to wildlife populations: criteria, assessment, and information gaps – Ex situ conservation, captive breeding, reintroductions, & translocations – Ecological restorations – Habitat degradation and loss – Factors influencing habitat loss and extinctions – Habitat fragmentation – Habitat corridors – Forest fire – Critical wildlife habitats –

Species invasions & introductions – Overharvesting of natural resources & sustainable use – Protected Areas – Island biogeography theory & reserve design - Conservation outside Protected Areas.

Practicals: Group discussions on conservation ethics and utilitarian values of biodiversity; group-assignments on select conservation issues and solutions; field visits to gain exposure to various conservation issues on the ground.

Module 24. Conservation Genetics

Units of genetics: chromosomes, genes, DNA, RNA, & proteins – Alleles & loci – Phenotypes and genotypes – Hardy-Weinberg principle & allele frequency - Basic molecular processes: replication, transcription, and translation – Mendelian laws of inheritance – Genetic code – Measuring genetic diversity in populations – Bottlenecks, genetic drift, and effective population size – Inferences about past history of population size and decline – Inbreeding and outbreeding – Metapopulation genetics – Population fragmentation, gene flow, and population differentiation – Hybridization and introgression – Use of molecular markers in ecology: techniques and case-studies – Molecular approaches in behavioural ecology: mating systems & parentage analysis, sex-ratios in population, and sex-biased dispersal – Phylogeography: concepts, bifurcating trees, and network analysis.

Applications of conservation genetics: wildlife forensics - Genetics of captive populations: pedigree and kinship analysis – Captive breeding & reintroduction strategies using genetic information.

Practicals: Lab exercises in conservation genetics and molecular ecology: collection and preservation of biological samples, DNA extraction, PCR, sequencing, and tree-building in phylogenies.

OCB-206. ELECTIVE PAPER -II

[Each student shall take ONE elective paper from the following options, provided the paper is opted by certain minimum number of students. List not exhaustive; more topics to be added based on representations from teaching faculty subject to approval]:

1. Applications of Multivariate Statistics in Ecology
2. Ethno-ornithology
3. Reconciliation Ecology
4. Restoration Ecology
5. Desert Ecology
6. High Altitude Ecology
7. Avian Forensics

OCB-207. TOUR ASSIGNMENTS & JOURNAL -II

OCB-208. RESEARCH DESIGN & COMMUNICATION WORKSHOP

SEMESTER-III

OCB-301. CONSERVATION BIOLOGY-II

Module 25. Climate Change Ecology

Introduction to the Earth's climate – Palaeoclimate: reconstruction from CO₂ – Dendroclimatology – Natural climate change – Anthropogenic climate change – Rising CO₂ & greenhouse effect – Global carbon cycle – Climate projections - General Circulation Models – Approaches for studying impacts of climate change: observational, experimental, and statistical – Carbon footprints – Measuring climate change vulnerability of species and habitats.

Spatio-temporal impacts of climate change on biological and ecological systems: physiological and behavioural responses – Impacts on migration and breeding phenology – Range shifts and species distributions – Changes in community composition and dynamics – Extinction risk - Species invasions – Habitat disturbances - Loss of critical wildlife habitats - Ecosystem responses: tropical forests, grasslands, montane forests, treelines & alpine vegetation, and coastal & marine ecosystems - Carbon sequestration and net primary productivity –Evolutionary responses – Interactive effects and positive feedbacks - Climate change & human ecology - Agricultural production and food security – Extreme weather phenomena - Climate justice – Climate change scenario for India: potential impacts and threats – Policy responses: mitigation and adaptation – National and International conventions and policies on climate change – IPCC & UNFCCC - Limitations of climate change studies and projections – Future research needs.

Practicals: Simulation exercises in different climate change projections and impact predictions; group-discussions on specific topics on climate change impacts and mitigation solutions.

Module 26. Ecotoxicology

Common pollutants in environment: inorganic, organic, gaseous and radioactive – Source and pathway of pollutants – Factors determining movement and distribution of pollutants – Comparative toxicology of terrestrial and aquatic ecosystems – Measuring toxicity in terrestrial and aquatic organisms – Biochemical and physiological effects of environmental contaminants in organisms – Additive effects of pollutants – Potentiation of toxicity – Role of biomarkers in ecotoxicological risk assessment.

Impacts of environmental contaminants on wildlife populations and communities – Changes in population dynamics in response to ecosystem pollutants – Case studies - evolution of resistance to long-term exposure to pollutants – Ecotoxicological monitoring fish and wildlife populations: principles, protocols, and guidelines.

Practicals: Hands-on training in instrumentation and other lab practices; collection and preservation of biological samples for ecotoxicological analysis; lab practicals in toxicity testing and measurement.

OCB-302. APPLIED ORNITHOLOGY

Module 27. Economic & Agricultural Ornithology

Birds in human lives: a historical perspective – Game hunting & bushmeat in the past - Overview of ecosystem services, functions, and goods rendered by birds – Regulation, provision, & information services - Economic evaluation of avian ecosystem services - Economic/agricultural ornithology in India – ICAR-AICRP/AINP on Agricultural Ornithology.

Control of insect pests in agriculture and forestry – Control of vermins and rodent pests – Pollination: ‘bird-flowers’ and ‘flower-birds’ – Seed dispersal & forest regeneration – Scavenging - Birds & their products as economic goods – Farming of wild birds for meat and eggs – Manures & guanos – Bird feathers & casques - Birds as indicators of environmental health – Merits and limitations of birds as ecological indicators – Birds as model systems in applied genetic studies – Avifauna as reservoirs of gene pool for use in poultry industry – Aviculture & pet trade – Pigeons in communication services – Falconry - Biomimicry & birds – Aerodynamic studies – Birdwatching as an emerging eco-tourism venture – Cultural, recreational, and aesthetic values of birds.

Damages caused by birds to food crops and fruits – Control measures - Birds as pests of granaries and warehouses – Birds as pests in pisciculture, apiculture, sericulture, and free ranging poultry farms – Role of birds in dispersal of weeds, parasitic, and invasive plants – Birds as vectors of pathogens and parasites – Zoonoses – Bird flu/avian influenza & role of migratory birds – Bird strike hazards to aircraft & their management – Damage to manmade structures.

Practicals: Field exercise to quantify intake of harmful insects by birds in agricultural fields; field observations on avian frugivory and seed dispersal; assessment of crop damage by birds in farms and orchards; interactions with farmers and planters.

Module 28. Bird Conservation & Population Management

Avian biodiversity – Levels of bird diversity: assemblages, communities, populations, demes, species, genes – Avifaunal diversity of the world & India – Rarity and endemism in birds – State of the world birds – Avian extinctions – Threatened birds & IUCN criteria for designation of threat categories - Major threats for bird populations - Prioritization of bird species for conservation – Influence of species concepts and taxonomy on bird conservation – Setting priorities in site selection for protection – Reserve selection algorithms – Adequacy of Protected Area network in covering avifaunal diversity – Birds as surrogates for biodiversity - Conservation of threatened avifauna outside PA network – Important Bird Areas (IBA).

Population management of threatened birds – Endangered species management: scope, principles, & methods – Population demography & conservation genetics of birds - Habitat, nests, food, & diseases – Anthropogenic threats & control – Captive breeding & ex-situ conservation of critically endangered birds – Population overabundance in birds.

Conservation and management of common birds – Recent declines in farmland birds and synanthropic birds – Synurbization in birds – Conservation of tropical birds – Bird conservation in human landscapes.

Illegal trade in wild birds & aviculture – Trafficking in wild bird populations & extinction risk – Indian scenario – CITES - Control measures – Legal & technical challenges in detection and conviction.

Practicals: Group discussion/seminar on specific issues of bird conservation with case-studies from India and South Asian region – Basic forensic techniques of species identification from bird parts.

Module 29. Bird Census & Population Monitoring

Bird populations & estimation of numbers – Historical review – Bird census and surveys – Measures of population estimate: total population, relative abundance, density, and indices - Importance of bird population monitoring – Basic considerations in population monitoring – Resource mobilization and planning – Role of volunteers – Spatial boundaries and temporal scope of monitoring protocol.

Bird surveys – Statistical considerations – Accuracy & precision – Sources of bias - Methods to increase precision – Survey design & sampling techniques – Simple vs systematic and random vs stratified sampling - Cluster sampling - Grid sampling - Sample size, sampling effort, and replication – Issue of pseudo-replication – Survey techniques for rare, elusive, and scattered populations.

Bird census techniques - Their applications, assumptions, & limitations – Territory mapping – Distance sampling: basic principles & field methods – Line transects – Belt transects – Point counts: fixed and variable width – Call counts - Mark-recapture framework – Principles of mist-netting - Types of marking birds: rings/bands, flags, tags, dyes, and natural markers – Radio-tracking of birds & satellite telemetry – Occupancy models for population abundance.

Field methods for estimating numbers of specific bird taxa – Seabirds – Waders/Shorebirds – Waterbirds – Raptors – Owls – Grassland birds – Forest birds – Urban birds – Counting breeding colonies & aggregations of migratory/roosting birds – Population estimation from indirect signs.

Bird atlas: considerations & methodologies – Citizen Science initiatives in bird population monitoring – US Christmas Bird Count & UK Breeding Bird Survey – Asian Midwinter Waterbirds Census – eBird.

Practicals: Field exercises in bird census techniques in forests, wetlands, and grasslands; conducting roost-counts and call-counts; demonstration of mist-netting, capture & handling of birds, bird ringing, etc; engagement with eBird programme and population trend analysis using eBird data.

OCB-303. WILDLIFE HEALTH & ZOO SCIENCE

Module 30. Wildlife Health & Animal Management

Overview of wildlife diseases and population management – Wildlife health and conservation in India: issues and perspectives – Epizootiology: patterns and factors of diseases in wildlife populations – Major diseases in Indian wildlife: viral, bacterial, mycotic/fungal, protozoan, and parasitic – Non-pathogenic ailments: nutrition deficiency, poisoning, stress, physical trauma, capture myopathy – Health

assessment: examination of live and dead animals for their health state and evaluation – Zoonoses: bacterial, viral, and fungal – Standard protocols for disease investigation in the field –Wildlife-livestock interface and disease management.

Overview of animal capture and handling: purpose, precautions, and follow-up procedures – Physical restraint and capture methods: nets, traps, cages, and other physical barriers – Chemical restraint and immobilization techniques: principles, drugs, dosage, delivery, and post-recovery monitoring.

Problem animals: definition, identification, and review – Marking of animals for monitoring – Restraint, handling, housing, and translocation of problem animals.

Practicals: Exercise in health assessment of wild animals and disease-risk evaluation; field diagnosis of diseases in wild animals; demonstration of physical restraint and chemical immobilization of wild animals; introduction to drugs and delivery devices; field-visits to study problem animals.

Module 31. Zoo Science & Conservation Breeding

Objectives and functions of zoos – Role of zoos in wildlife conservation and education – Classification & management of zoos in India – Central Zoo Authority of India – Zoo legislation & policy - International organizations and conventions in zoo management – Issues of animal ethics, rights and welfare in captive animals.

Design of zoos, enclosures, and exhibits – Considerations on space, enhancement, hygiene, food, and nutrition – Zoo animal behaviour: stereotypic behaviour, environmental enrichment, visitor-captive animals interactions, and normalization procedures – Animal health and veterinary care – Record keeping: marking & identification, pedigree documentation, & studbooks - Captive breeding for *ex situ* conservation of threatened animals: principles, population genetics, demography, and re-introduction protocol.

Zoo education & research – Interpretation centres – Zoo signage and information materials – Visitor facilities & responsibilities – Behavioral and conservation research on zoo animals: case-studies from Indian zoos.

Practicals: Visits to zoos and captive breeding centres; field-exercise in quantifying zoo animal behaviour; documentation of visitor experience and behaviour in zoos.

OCB-304. WILDLIFE MANAGEMENT & POLICY

Module 32. Principles of Wildlife Management

Wildlife management & conservation: historical review and objectives – Comparison of different global models of wildlife management: American, European, African, and Indian – Protected Area (PA) network in India: types of PAs, land use policies in PAs, zonation and buffering, and ecological sensitive zones - Project Tiger and Project Elephant – Biosphere Reserves - Village forests & community forests - Design of PAs & SLOSS debate – Wildlife Management Plans – Planning and execution of wildlife conservation

programmes: planning agency, roles and responsibilities, policy guidelines, role of conservation NGOs, and citizen science initiatives in wildlife population monitoring - Role of local communities in wildlife conservation.

International laws, conventions, and treaties on wildlife conservation – Convention on Biological Diversity, CITES, Convention on Migratory Species (CMS), Ramsar Convention, World Heritage Convention – Major Indian wildlife and forest laws – Indian Forest Act 1927, Wild Life (Protection) Act 1972, Forest (Conservation) Act 1980, Biological Diversity Act 2002, & Forest Rights Act 2006.

Managing wildlife habitats: PA governance, forest fire, flood & drought, plantation management, forestry operations, and collection of NTFPs – Methods of habitat improvement: amplifying food and foraging opportunities, waterholes, maintaining wetlands, cover management, facilitating breeding and nesting activities, protection of breeding microhabitats like dens, tree holes, caves, etc, and installing trenches and fences for critical site protection – Control of feral dogs, feral cattle, introduced populations, and invasive plants in PAs - Ecological restoration - Animal damage: control vs management, crop and property damage, population culling, and control methods (biological, mechanical, and chemical) – Wildlife tourism & case-studies from successful ecotourism initiatives in India.

Basic tools in wildlife management: RS & GIS maps and toposheets, radio telemetry, satellite tracking, and use of radio-isotopes – Wildlife population monitoring protocols for forest staff: terrestrial, wetlands, and marine PAs – Application of modern tools and techniques in wildlife management.

Practicals: Field visits to different PAs in terrestrial and aquatic ecosystems to interact with forest managers and to study various management issues and development of wildlife management plans for selected taxa and sites.

Module 33. Human-Wildlife Conflicts & Management

Human-wildlife conflicts: overview, history, current trends and issues – Impacts on humans: human mortality & injury, livestock depredation, crop damage, property damage, loss of livelihood opportunities, and contraction of diseases – Impacts on wildlife populations – Economics of human-wildlife conflicts: economic assessment of damages, opportunity costs, and cost-benefit analysis – Societal attitudes to human-wildlife conflicts – Stakeholders perceptions: tribals & forest dwellers, farmers & land owners, wildlife managers, conservationists, wildlife enthusiasts, animal welfare/rights activists, urban communities, and rural populations.

Managing human-wildlife conflicts through animal dimensions: lethal control, fertility control, shifting of problem animals, fear stimulation, chemical repellents, diversion tactics, exclusion, and habitat manipulation – Managing human-wildlife conflicts through human dimensions: changing human behaviour and lifestyle, increasing tolerance through education and awareness campaigns, timely monetary compensation for wildlife damage, and recompensing opportunity costs.

Practicals: Field visit to sites where human-wildlife conflicts are common and interactions with forest officials on managing conflicts; group-discussions on specific conflict issues and mitigatory measures;

conducting questionnaire surveys among local stakeholders to quantify degree and seasonality of human-wildlife conflicts and their attitudes to the issue.

Module 34. Environmental Impact Assessment

Environmental Impact Assessment (EIA): origin, concepts, and policy framework – Components of EIA planning – Scoping – Environmental base maps & information – Identification of parameters – Impact analysis – Draft Environmental Impact Statements – Analysis of alternatives – Prescriptions for mitigation.

EIA methods: soil and ground water, surface water, air, noise, biodiversity, ecosystems, and socio-economics – Rapid surveys for wildlife populations and habitats – Ecological indicators - Environmental Risk Assessment – Environmental cost-benefit analysis – Types of development projects & EIA implications - Cumulative EIAs - Application of remote sensing and GIS tools in EIAs – Environmental capital & livelihood security – Sustainability appraisal in EIAs – Adaptive management solutions – Biodiversity offsetting - Efficacy & limitations of EIAs – Environmental monitoring & auditing – Uncertainty in EIAs – Capacity shortfalls.

Practicals: Field visits to project/development sites to observe how EIAs are conducted; field-exercises in rapid assessment of wildlife populations and habitats; class-room seminars in specific issues of EIAs in developing countries.

OCB-305. TOUR ASSIGNMENTS & JOURNAL -III

SEMESTER-IV

OCB-401. DISSERTATION & VIVA VOCE