# Ecology
## Course Structure

**Semester III**

| Course No. | Course Title | Nature of course | Credit hrs | Full Marks |
|---|---|---|---|---|
| Eco 601 | Ecological Theories and Principles | T | 4 | 100 |
| Eco 602 | Quantitative & Spatial Ecology | T | 4 | 100 |
| Eco 603 | Conservation Biology | T | 4 | 100 |
| Eco 604 | Ecosystem Management & Research Methodology II | T | 4 | 100 |
| Eco 605 | Quantitative & Spatial Ecology | P | 2 | 50 |
| Eco 606 | Conservation Biology & Ecosystem Management | P | 2 | 50 |
| Eco 607 | Dissertation Proposal & Seminar | | 1 | 25 |
| Total | | | **21** | **525** |

**Semester IV**

| | | | | |
|---|---|---|---|---|
| Eco 651 | Mountain & Global Ecology | T | 3 | 75 |
| Eco 652 | Thesis | | 4 | 100 |
| **Total** | | | **7** | **175** |

## Semester III

## Ecology

**Course Title: Ecological Theories and Principles** **Credits: 4**

**Course No.: Eco 601** **Lecture hrs: 60**

**Nature of the Course: Theory** **Full Marks: 100**

**Pass Marks: 50**

### Course Objective

To provide existing knowledge of ecological theories and principles used in terrestrial and aquatic environment.

### Course Contents

**Population Growth and Regulation** **15 hrs**

**Population Growth:** Theories on population growth (Mathematical theory), population growth models: exponential growth, logistic growth, time lags, stochastic model, population projection matrices.

**Population regulation:** Density dependent regulation- Intraspecific competition, growth and fecundity. Self thinning theory. Density independent regulation. Population fluctuation and cycle. Carrying capacity. Population extinction.

**Species Interaction** **15 hrs**

**Inter Specific Competition**: Concept, Theories and Models of Competition. Studies of competition. Resource Partitioning. Differential Resource Utilization. Ecological Niche: Niche overlap, niche width and niche change.

**Predation**: Concept, Theories and Models of Predation, Predator- Prey System, Functional Response, Numerical Response, Foraging Theory, Predator- Prey Dynamics/Cycle.

Plant- Herbivore Interaction.

**Ecosystem & Community Ecology** **15 hrs**

**Global Biogeochemical cycles:** Concept, types and role of biogeochemical cycles in ecosystem, cycles and human impacts on Carbon, Nitrogen, Phosphorus and Sulphur. Acid rain and associated cycles, Chlorinated Hydrocarbon.

**Community Ecology:** Structure: Concept, Physical Structure, Biological Structure in terrestrial and aquatic Community, Edge Community, Island Community, Community Patterns.

**Community pattern in space**: Gradient analysis. Classification and ordination of community. Community boundaries.

**Succession/Ecosystem Development:** Concept, Types and patterns of succession, Trends of changes in ecosystem attributes, Models of succession and Concept of climax.

**Landscape Ecology & Biogeography** **15 hrs**

**Landscape Ecology:** Fundamentals of Landscape Ecology (genesis, definition and concepts); Characteristics of landscape structures, Scales; Landscape Pattern and Process; Landscape Dynamics and its Implication, Drivers of landscape change.

**Biogeography**: Concept and distribution of Biome, Theory on Island biogeography, Biogeographic affinities of fauna of Nepal

## References


Begon, M., J.L. Harper, C.R. Townsend. 1996. Ecology. Blackwell Science, Massachusetts, USA.

Bormann, H. & G.E. Likens. 1979. Ecosystem development: patterns and processes. Springer-Verlag, New York.

Campos-arceiz, A., A.R. Larrinaga, et al. 2008. Behavior rather than diet mediates seasonal differences in seed dispersal by Asian elephants. Ecology **89**(10): 2684-2691.

Huston, M.A. 2002. Biological diversity. Cambridge University Press, Cambridge, U.K.

Janzen, D.H. 1980. When is it coevolution? Evolution **34**(3): 611-612.

Jennifer L. F. & P.M. Vitousek. 2007. Resource-use efficiency and plant invasion in low-resource systems. Nature 446. |26 April 2007| doi:10.1038/nature05719

Krebs, C.J. 1996. Ecology harper Collins College Publishers, Inc. New York.

Likens, G.E & H. Borman. 1981. Bigeochemical cycles. Springer-Verlag, New York.

Odum, E.P. 1971. Fundamentals of Ecology. Saunders College Publishing, Philadelphia USA.

Smith & Smith 1998. Ecology and Field Biology. Benjamin Cumming, USA.

Turner et al. 2001. Landscape Ecology in Theory and Practice, Springer. Lecture notes by K. McGarigal; and assigned journal articles.


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**Semester III**

**Course Title: Quantitative & Spatial Ecology** **Credits: 4**

**Course No.: Eco 602** **Lecture hrs: 60**

**Nature of the Course: Theory** **Full Marks: 100**

**Pass Marks: 50**

## Course Objective

To provide students with a broad knowledge of ecological phenomena at spatial level and quantitative tools in ecology applications of ecological models.

## Course Contents

**Quantitative Ecology and Ecological Models** **30 hrs**

**Basics of Quantitative Ecology and Ecological Models:** Introduction – concept and scope, ecological data/classification. Ecological ordination and gradient analysis: Principal component analysis (PCA). Correspondence analysis (CA) and Detrended Correspondence Analysis (DCA). Ecological models: Nature of ecological/mathematical models. Development of ecological models. Single population and two populations examples.

**Ecological Methods:** Terrestrial environment and aquatic environment: Sampling – size, number, timing. Quadrat and transects –types, sizes, and numbers. Absolute population estimate – marking technique (capture-recapture). Relative population estimate. Population estimates of wildlife - Data collection by direct and indirect methods; Indices of population abundance, direct count, sample count, Camera trapping and analysis,

**Spatial Ecology:** **30 hrs**

**Remote Sensing**

**Basics of Remote Sensing**: Concept, brief history, physical basis of remote sensing, electromagnetic spectrum, atmospheric effects, types of remote sensing, resolution types, EMR interactions and spectral signatures.

**Satellites and Sensors**: Concept of platform. Satellites- types and characteristics of operational remote sensing satellites. Sensors- types.

**Image Analysis : Visual Image Interpretation**: Tools and techniques, elements of image interpretation (Aerial photo interpretation). **Digital Image Processing:** Digital image, characteristics, image resolution (Spectral resolution, radiometric resolution, spatial resolution and temporal resolution), image pre-processing (Feature Extraction, Radiometric Corrections, Geometric Corrections, Atmospheric Correction), image enhancement, extraction of information and classifications, supervised and unsupervised classification and accuracy assessment.

**Application of Remote Sensing in Natural Resource Management**: Case Studies presentation.

**Global Positioning Systems (GPS):** Concept, History, GPS systems, Sources of Errors, Differential GPS, Application of GPS.

**Geographic Information System (GIS):** Basic concepts and components of GIS; Data: sources of data, spatial and non spatial data, database; Maps- types of maps; Projection- Types of projection and coordinate system; Data Input- Digitizer, Scanner Raster and Vector data structure; Spatial analysis: proximity and overlay analysis (measurement, overlaying, neighborhood and connectivity); Outputs; Map design; Integration of GIS and Remote Sensing.

Application of Geographic Information Systems in Natural Resource Management.

## References


Aronoff, S. 2005. Remote Sensing for GIS Managers. ESRI Press.

Burrough, P. A. & R.A. McDonnell. 1998. Principles of Geographical Information Systems. Oxford University Press.

Heywood, I., S. Cornelius & S. Caver, 2006. An Introduction to Geographical Information Systems. Prentice Hall.

Jensen, J.R. 2000. Remote Sensing of the Environment: An Earth Resource Perspective. Prentice Hall.

Krebs, C.J. 1999. Ecological Methodology ($2^{nd}$ Ed). Addison-Wesley Longman Publication

Lillesand, T.M., R. W. Kiefer &J..W. Chipman, 2004. Remote Sensing and Image Interpretation. John Wiley & Sons.

Reddy, A. 2001. Remote Sensing and Geographical Information Systems, BS Publications.

Richards, J. A. J. Xiuping, 2006. Remote Sensing Digital Image Analysis: An Introduction (4th ed.). Springer.

Williams, B.K., J.D. Nichols & M.J. Conroy. 2001. Analysis and management of Animal Populations. Academic Press.


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**Semester III**

**Course Title: Conservation Biology** **Credits: 4**

**Course No.: Eco 603** **Lecture hrs: 60**

**Nature of the Course: Theory** **Full Marks: 100**

**Pass Marks: 50**

## Course Objectives:

To provide students with a broad knowledge of conservation of threatened species, wildlife ecology and their management.

## Course Contents

**Biodiversity Conservation** **30 hrs**

**Conservation Biology:** Concept, scope, fields and history of conservation ecology.

**Biodiversity:** Concept, Scope. Hierarchical levels and values of biodiversity, conservation and ethics. National Policy and implementation measures towards The Convention on Biological Diversity (CBD).

**Patterns and processes**: Patterns in space and time, Factors regulating biodiversity patterns,

**Biodiversity hotspots**: Concept and distribution of biodiversity hotspots.

**Measuring biodiversity** - Inventory, assessments and mapping.

**Threats to biodiversity:** Natural and anthropogenic threats. Concept and categories of Threatened species of Nepal. Endangerment and extinction; causes and process of endangerment and extinction, mass extinction and background extinction and vulnerability to extinction.

**Conservation approaches and strategies**: Introduction: traditional, conventional and community- based approaches; current practices (*in-situ* and *ex-situ* conservation); protected areas, conservation policies and legislation.

**Population approach**: Conservation biology of small populations: Minimum viable population, loss of genetic variation, effective population size, demographic and environmental stochasticity, Extinction vertex. Small population approach and declining population approach, meta-population: concepts, population viability analysis, optimal harvesting and population management, establishing new population.

**Species Approach:** Single Species Approach **(**flagship, umbrella, keystone and indicator species) and Multi-Species Approach (Focal species, landscape species), Translocation, Reintroduction and species action plan.

**Landscape Approach:** Managing the matrix, challenges and opportunities, landscape-based models for conservation: corridors and trans-boundary conservation, integrated conservation and development.

**Ecoregion Approach**: concept, scope, principles and scales of ecoregion.

**Ethno-biology** **8 hrs**

Introduction, history, concept, scope and perspective. Sub-discipline of ethno-biology. Application of ethnobiology, principles of ethnobiology. Status and Field of ethnobiology in Nepal. Field and Laboratory methods of ethnobiology. Code of ethics and guidelines for ethnobiological research. Ethnobiology and Indigenous knowledge system, ethnobiology and medicine, health and nutrition, ethnobiology and ecology, evolution and systematics, ethnobiology and landscapes and global trends, ethnobiology and biocomplexity, ethno-biology and biological, cultural and linguistic diversity conservation.

**Wildlife Ecology** **22 hrs**

Ecology and behavior of important species: tiger, red panda, rhinoceros, elephants, snow leopard, blue sheep, Himalayan black bear, sloth bear, assamese macaque, swamp deer, black buck, dolphin, small mammals, vultures and crocodiles etc.

**Behavioural Ecology:** Foraging, Social organization, Communications.

**Values of wildlife, Habitats**: Components, Habitat Suitability Index, Habitat Evaluation Procedure, Diet Analysis of Carnivore and Herbivore.

**Wildlife Management**: Principles of Wildlife Management; Management goals; Tools and techniques of management: Habitat Management, Population management, Health management, Law enforcement.

## References


Braun, C. E. 2003. Techniques for Wildlife Investigations and Management. The Wildlife Society, USA.

Braun, C.E. &W.L. Robioson. 2003. Wildlife Ecology and Management. Prentice- Hall, Upper Saddle River, New Jersey.

Groom, M., J. Gary, K. Meffe & C.R. Carroll. 2006. Principles of Conservation Biology. 3rd edition. Sinauer Associates, Inc., Sunderland, MA, USA.

Primack, R.B; P.K. Poudel & B.P. Bhattarai. 2013. Conservation Biology: A Primer for Nepal. Dreamland Publication, Kathmandu

Primack, R.B. 2010. Essentials of Conservation Biology (5th ed.). Sinauer Associates.

Sinclair, A.R. E., J.M. Fryxell, &G. Caughly. 2006. Wildlife Ecology, conservation and management. 2nd edition. Blackwell Publishing, USA. ISBN 1405107375.

Singh, N.B. 1997. The Endangered Raute Tribe: Ethnobiology & Biodiversity", published by Global Research Carrel for Ethnobiology, (GLORECA "Ethnobiology"), Kathmandu, Nepal.

Sodhi, N.S. & P.R. Ehrlich. Conservation Biology for All. http://www.mongabay.com/conservation-biology-for-all.html.

Williams, B.K., J.D. Nichols & M.J. Conroy. 2001. Analysis and management of Animal Populations. Academic Press.


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**Semester III**

**Course Title: Ecosystem Management & Research Methodology II** **Credits: 4**

**Course No.: Eco 604** **Lecture hrs: 60**

**Nature of the Course: Theory** **Full Marks: 100**

**Pass Marks: 50**

## Course Objective

To provide students with a broad knowledge of ecological phenomena, analytical tools and techniques, and applicable technology in ecological field for the natural resource management and environmental conservation.

## Course contents

**Ecosystem management**: **30 hrs**

Integrated ecosystem management, Ecosystem resilience and key elements, Watershed management (concepts and practice), Characteristics, status and distribution of wetlands in Nepal (with particular focus on Ramsar sites and recent initiatives), Restoration Ecology: Concept, strategies and recent initiatives.

**Environmental Impact Assessment**: Introduction: Concept of EIA, IEE, SIA, and objectives. History - Evolution/development from national and international perspective. Policy- General EIA and EIA related policies and acts including environmental policies and acts of Nepal. Project screening and initial environmental examination: Objective, criteria; factors and timing of the IEE. Scoping: Methods, responsible organizations, timing, terms of reference for EIA. Identification of environmental impacts: Types of impacts. Methods of impact identification (existing environmental conditions, altered conditions, impact prediction and impact ranking). Environmental impact mitigation measures and enhancement. Environmental Impact Monitoring- types, principles, process and timing. Environmental Impact Auditing – types, process and timing. Preparing Environmental Report- Integration of screening, scoping, and detail EIA.

**Research methods and Biostatics: Research Designing - Thesis/paper writing**: **30 hrs**

**Introduction**: Background and identification of research problem, objectives, justifications.

**Research design**: Hypothesis setting, types of research design, principles of experimental designs; sampling, types of sampling (simple random sampling, stratified random sampling, systematic sampling, cluster sampling, multistage sampling); basic unit of study and variables for measurement, data collection (primary and secondary) and analytical tools (see below).

**Data analysis**: Hypothesis testing, measurement of central tendency, dispersion, relationship (simple correlation and regression analysis), multiple correlation and regression, chi-square test, t-test and z-test, analysis of variance (ANOVA) and analysis of covariance (ANCOVA), Multivariate analysis (see above). Interpretation of results: outcome of the data analysis, acceptance and rejection levels, assumptions, evidence from literature, and tentative conclusion.

Thesis, scientific papers and reports writing.

## References

CDZ .2009. Biostatistics: A Handbook for Students of Biological Sciences. Kathmandu

Cox, C.B. & P.D. Moore. 2007. Biogeography. Blackwell Publishing, Massachusetts, USA.

Hicks, R. C. 19… Fndamental concepts in the Design of Experiments. Holt, Inehart and Winston, New York.

Kothari, C.R. 2000. Research Methodology. Vishwa Prakashan, New Delhi.

Krebs, C.J. 1996. Ecology. Harper and Collins College Publishers, Inc. New York,

Odum, E.P. 1971. Fundamentals of Ecology. Saunders College Publishing, Philadelphia USA.

Richards, C., K. Basnet et al. 2000. Grassland ecology and management in protected areas of Nepal. Volumes 1-3. ICIMOD, Kathmandu.

Singh, J.S., S.P. Singh & S.R. Gupta. 2006. Ecology Environment and Resource Conservation. Anamya publishers, New Delhi, India.

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**Semester III**

**Ecology**

**Course Title: Dissertation Proposal & Seminar** **Credit: 1**

**Course No.: Eco 607** **Lectures: 60**

**Nature of the Course: Research** **Full Marks: 25**

**Pass Marks: 12.5**

## Objective

To strengthen the knowledge of students in research based academic activities and to develop a research proposal of thesis for semester IV.

The students will select topic for their research work related to their special/elective paper. The students will prepare a research proposal by studying published research works in the related area. The research proposal will be discussed with research committee of the department. After which the department will formally appoint supervisor/s for the research project. Each student will work for research under the supervision of assigned supervisor in the department. After completing the proposal, it is mandatory to present in a seminar.

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**Semester III**

**Course Title: Quantitative & Spatial Ecology** **Credits: 2**

**Course No.: Eco 605** **No. of Practicals: 30**

**Nature of the Course: Practical** **Full Marks: 50**

**Pass Marks: 25**

## Course Objectives

- To acquaint the students practically with sampling techniques in both terrestrial and aquatic habitats with climatic data analysis and remote sensing.
- To provide students with practical knowledge

## Course Contents

**Ecological methods in terrestrial and aquatic environment:**

**a) Sampling:**

- Determining sample size and timing. Quadrat method - types, size and their use (at least one example of each). Transect methods - types, size/length and their use (at least one example of each). Trapping/collecting, bin sampling, grab sampling etc. Aerial sampling.

**b) Population measurement**:

- Population structure and composition. Population growth/increase. Construction of life table .

**Community analysis:**

**a) Community measurement:**

- Biodiversity. Structure and composition. Community diversity indices. Community similarity indices.

**Climate analysis:** Using real secondary data (At least 20 years) from metrological stations.

- Temperature variations – Daily, monthly, seasonal, annual; long-term periodic.
- Local and regional trend of temperature change.
- Analysis of Precipitation and humidity using secondary data.

**Remote sensing and GIS:**

- Visual Interpretation of images, Transfer of Information from Imagery to Base Map.
- Display of digital image: Single band and multiple band images and digital numbers.
- Image enhancement: Contrast enhancement, linear stretching, histogram equalization, etc.
- Georeferencing of digital images. Rationing and Normalised Rationing and NDVI analysis.
- Image classification –Supervised classification and unsupervised classification.
- Explore various software's used for Remote Sensing image analysis and GIS.
- Acquisition of Google Earth images for land use/ land cover mapping.
- Interaction of GIS and RS/ toposheet data – digitization, raster-vector conversion, etc.
- Spatial data collection by using GPS.

**Semester III**

**Course Title: Conservation Biology & Ecosystem Management** **Credits: 2**

**Course No.: Eco 606** **No. of Practicals: 30**

**Nature of the Course: Practical** **Full Marks; 50**

**Pass Marks: 25**

## Course Objectives

To acquaint with the techniques in the study of biodiversity measurement, wildlife management

To provide students with practical knowledge

## Course Contents

**Biodiversity conservation:**

- Biodiversity Assessment: Biodiversity survey/inventory- Extensive and intensive methods (at least one example of each). Developing database (simple electronic database). Measuring conservation status - Conservation value, conservation threat and indices

**Measuring species diversity:** Experiment associated factors.

**Ecosystem and Wildlife management:**

- Population census/estimation: Direct and indirect methods/survey. Camera trapping: Field preparation and setting cameras. Data Collection and analysis. Wildlife darting and translocation: Demonstration/observation.

- Diet analysis, Habitat evaluation and Behavior observation.
- Altitudinal variations in edaphic factors: Soil composition, soil profile, Soil moisture and permeability, acidity, alkalinity, humus contents and determination of carbon stock in soil.

- Altitudinal biodiversity gradients in nearby areas.

- Vertical faunal diversity in nearby pond..

- Analysis of faunal diversity of aquatic habitats (polluted and unpolluted).

- Physico-chemical analysis (polluted and unpolluted water bodies).

**Ethino-biology:**

The study of relationships between particular ethnic groups and their native plants and animals

**Ecological data analysis using available softwares.**

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**Semester IV**

**Ecology**

**Course Title: Mountain & Global Ecology** **Credits: 3**

**Course No.: Eco 651** **Lecture hrs: 45**

**Nature of the Course: Theory** **Full Marks: 75**

**Pass Marks: 37.5**

## Course Objectives

To make the students to understand biodiversity in the mountain and its ecology with the impacts of climate change and biological invasion..

## Course Contents

**Mountain Ecology** **22 hrs**

Introduction, origin and evolution of mountains, major mountain ranges and their characteristics, vulnerability of mountains (Mountain natural hazards, causes and mitigations.- Landslides, flood, and earthquake),

**Himalayan mountain:** Himalayan natural resources and biodiversity, environmental degradation- Deforestation, loss of biodiversity, agriculture), impacts of tourism. Prospects for future development in the Himalaya.

**Mountain biogeography:** Theory and practice; Examples from the Himalaya. Ecology and conservation of Himalayan biodiversity hotspots.

**Climate** **23 hrs**

**Climate change**: Introduction to climate change, Green house gases and climate forcing agents, Current scenario of climate change processes and international initiatives; Climate change impacts on terrestrial and aquatic ecosystems; biodiversity; diseases, shifting of species range.

Prediction and biological indicators, policy and strategy, mitigation measures and adaptations & preparedness.

**Biological Invasions:** Invasive alien species, theories and hypotheses of biological invasion. Invasive alien species of Nepal (animals and plants), Impacts of biological invasion on economy, ecology, health and biodiversity, Mitigation & adaptation practices and policies, Impacts of exotics on biodiversity, productivity, nutrient cycling. Management: Bio-control programmes, mechanical and chemical control.

## References

Barber, N.A., R.J. Marquis and W. P.Tori. 2008. Invasive prey impacts the abundance and distribution of native predators. Ecology 89(10): 2678-2683.

Bilham, R.,P.Bodini & M. Jackson. 1994 Entertaining a Great Earthquake in Western Nepal: Historic Inactivity and Geodetic Test for the Development of Strain. In: Journal of the Nepal Geologic Society, Volume 11, Special Issue.

Chalise, M.K. 2013. Mountain Ecology and Natural Hazards. Nepal Biodiversity Research Society, Lalitpur. p. 95+6.

DHM. 2001. Tsho Rolpa Glacier Lake Outburst Flood Risk Reduction Project. Kathmandu: Department of Hydrology and MeteorologyGurung, H. 2000. Mountains of Asia: a Regional Inventory. ICIMOD, Nepal.

Dixit, A.M. 2005. Experiences of Earthquake Risk Management in Nepal. In Disaster Management Achievements and Challenges. Kathmandu: NEC and Ehime University.

Ives, J. D. 2006. Himalayan Perceptions. HimAAS, Nepal.

Korner, C. & E.M. Spehn. 2002. Mountain Biodiversity. The Parthenon Publishing Group, New York.

Pradhan B.K. 2007. Disaster Preparedness for Natural Hazards: Current Status in Nepal. ICIMOD, ISBN 9789291150304. P.96.

Peters, R.L. & Thomas E. Lovejoy 1992. Global Warming and Biological Diversity. Yale University Press, USA.

Preisser, E.L. & J.S. Elkinton. 2008. Exploitative competition between invasive herbivores benefits a native host plant. Ecology 89(10): 2671-2677.

Sharma, C.K. 1990. Geology of Nepal Himalaya and Adjacent Countries. Kathmandu, Nepal.

Yunling, H,, & Y. Zhang. 2005. Climate Change from 1960 to 2000 in the Lancang River Valley, China. Mountain Research and Development 25(4):341-348.

## Semester IV

## Ecology

**Course Title: Thesis** **Credits: 4**

**Course No.: Eco 652** **Full Marks: 100**

**Nature of Course: Research (Compulsory)** **Pass Marks: 50**

### General Objective

To produce M.Sc. dissertation based on original research study in priority areas of Ecology.

### Specific Objective

- To develop scientific observation of natural phenomenon, skill to analyze and understand for logical interpretation.
- To know various methodological tools including instruments and apply them in the field studies.
- To develop confidence on seminar presentation and defend the dissertation work.

### Dissertation Work

The dissertation work is compulsory for all students in order to develop skills and handle the research study independently. The students work on the proposal developed in Zoo 607 of semester III under the formally appointed dissertation supervisor/s. However, the student is able to work independently and has to take full responsibility in completing the proposed task on time. The supervisor should be available for consultation and review. The dissertation is evaluated by a committee of experts including an external examiner. Students have to present their work and defend it in a public defense.

The Student must complete a dissertation work and should submit it within the academic session of the fourth semester. The duration can however be extended by the research committee with the consent of the head of the department on student's request form and recommendation of the concerned supervisor with reasonable explanation.

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